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Offline Sanskirthandwritten Character Recognition Framework Based on Multi Layerfeed Forward Network with Intelligent Character Recognition

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Abstract: Character recognition is the electronic translation of scanned images of handwritten or printed text into a machine encoded text or typewritten. Sanskrit, an alphabetic script is used by over 500 million people all over the world. Handwritten scripts of Sanskrit are complicated compared to other language scripts. The greatest challenge in the field of image processing is to recognize the documents both in printed and handwritten format. The character recognition is a standout amongst the most generally utilized biometric attributes for authentication of persons and document. In this study, proposed an off line handwritten Sanskirt character recognition framework utilizing multilayer feed forward neural network. Efficiency and accuracy are the main parameters in the field of handwritten character recognition. Intelligent Character Recognition (ICR) is a procedure used to enhance the efficiency and accuracy of theoff line handwritten Sanskirt character recognition system which is involved various technologies aimed at the analysis and recognition of handwritten Sanskirt characters from an electronic image. This framework will be suitable for converting handwritten documents into the structural content form and recognizing handwritten characters. A novel approach to achieve a very fast recognition rate and high accuracy rates compare with other recognition systems.

Key words: Neural network, intelligent character recognition, offline handwritten character, novl approach, India

INTRODUCTION

Recognition of handwritten character is the most interesting topics in pattern recognition. The handwritten character recognition system is classified as on-line and off-line system. The probability of recognizing handwriting information with digitizer as a time sequence of pen coordinates is known as on-line character recognition. In off-line system, the writing is typically captured optically by a scanner and it is available as an image. It involves automatic translation of text in an image into letter codes that are usable within the computer.

A Neural Network (NN) is an information processing standard that is inspired by the way natural nervous systems, for example, the brain, process information. The key component of the NN standard is the novel structure of the information processing framework. It is made out of a substantial number of exceptionally interconnected processing components (neurons) working as one to tackle particular issues. A NN is designed for a particular application, for example, data classification or character recognition, through a learning methodology (Verma and Kaur, 2014). An Intelligent Character Recognition (ICR) system typically consists of numerous sequential functional components or tasks are form distribution, form designing, form registration, feature-extraction from the field-image, field image extraction, field recognition.

Many of today's document scanners for the Personal Computer (PC) accompany software that performs a task known as Intelligent Character Recognition (ICR). The ICR software permits to scan in a printed document and after that change over the scanned image into an electronic text format, for example, a word document. In this way to perform this conversion the software must analyze each other values, one group of pixels (0's and 1's) that structure a letter and produce a value that compares to that corresponds letter. Some of the ICR software on the market utilizing a neural network as the classification engine. Offline character recognition includes the programmed transformation of hand printed character (as a picture) into letter codes which are usable inside machine and text-processing applications. As contrasted with on-line; off-line character recognition is comparatively problematic as diverse individuals have distinctive handwriting styles furthermore the characters are concentrated from documents of diverse background and intensity (Choudhary and Rishi, 2011). Nevertheless, restricting the scope of varieties in information can allow recognition procedure to improve.

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The network is trained by the supervised learning method. The aim is to train the network to accomplish a balance between the capability to respond correctly to the input characters that are utilized for training and the ability to provide better responses to the input that were similar.

In this research, Sanskrit handwritten characters are recognized through multilayer feed forward neural network with three hidden layers. For training, back propagation algorithm has been applied. The network can be utilized to learn the character in the format of patterns and then generalizing from the trained network and recognizing the character that is obtainable in the form of an image.

Following are the main objectives of a character recognition system that can recognize Sanskrit characters are to classify a given input in a character image into a binary pattern image and to implement data structures and algorithms for handwritten Sanskrit characters.

To implement image processing and neural network based implementation that will be utilized to alter any pre-processed and scanned document of handwritten Sanskrit character to the machine readable method. Three hidden layers and multi perception are used for handwritten Sanskrit character recognition and the features are concentrated from the handwritten characterto limit the following Fourier descriptor. Here, the structure of the character is analyzed and features are contrasted with recognizing each one character. The normalized binary pixels of the Sanskrit characters were utilized as the inputs of the network.

Literature review: Recognition approaches depend on the nature of the information to be recognized. As neural network is used here for recognition of offline Sanskrit character images and it has been seen that recognition expands in spite of the fact that at a slow rate. There is some time results vary from the original image because of the quantity of character set used for preparing was sensibly low. As the network is prepared with more number of sets, the correctness of recognition of characters will doubtlessly expand. It might be reasoned that the work has effectively done the character recognition (Kumar and Bhatia, 2013).

The importance of selection for the recognition system and features extraction to perform well as well as focused on segmentation based strategies as far as off-line handwritten word recognition is concerned these strategies were suitable for small lexical only (Choudhary and Rishi, 2011). The character recognition capacity of feed forward, back-propagation neural network by utilizing one, two and three concealed layers and the changed extra momentum term. The 182 Sanskrit letters were gathered for proposed research and the comparable binary matrix type of these characters was connected to the neural network as training examples. The connection weights were changed at every epoch of learning. For each one training example, the mistake surface was analyzed for minima by computing the gradient descent.

The Bangla 'Sorborno' and 'Banjonborno' characters have been selected to test the recognition System. Two stages are obliged to actualize this recognition process. They are learning stage and testing stage (Moon and Sarker, 2011). In learning stage, the character to be perceived is filtered through a scanner and therefore the character turns into a bitmap picture. At that point, the limit area of the saved image is concentrated. The peculiarity of the scaled image is concentrated and changed over into a m x n matrix which is lessened to little matrix, for example, 16×16 utilizing by the features of matrix is used in the multilayer feed forward Neural Network. The supervised learning framework is considered for driving the feed forward algorithm. On testing stage, the features have been contained enough information inside, it to recognize each one character class extraordinarily. Finally, obscure each character are tried through the exploratory extracted features of character.

The Bangla speech recognition uses back-propagation neural network. Ten bangla digit formats were recorded from ten speakers and have been recognized. The structures of these speech digits were mined by the approach of Mel Frequency Cepstral Coefficient (MFCC) analysis. The MFCC uses the features of five speakers were utilized to train the network with a back propagation algorithm (Hossain *et al*., 2013).

A novel method called diagonal based feature extraction is used for extracting the features of the alphabets from handwritten document (Pradeep *et al*., 2011). The approach employs the conventional vertical and horizontal methods of feature extraction. A framework for recognizing isolated digits may be utilized an approach for dealing with the neural network application. In other words, to let the computer recognizes the Arabic numbers that are written by users and views them rendering to the computer process (Al-Omari *et al*., 2009).

The class modularity concept of the feed forward neural network classifier the class segmental concept, the original K-classification issue is decomposed into K 2 classification subproblems. A modular framework is adopted which consists of K subnetworks, each responsible for perceptive a class from the other K 1 classes. The effectiveness of class sectional neural networks in terms of their recognition power and

convergence (Al-Omari *et al*., 2009). The ICR system is reliable, providing properly tested confidence values, scanning parameters and validation checks are intelligible to each other (Sharma and Sharma, 2010).

A novel algorithm, called Radial Sector Coding (RSC), for rotation, translation and scale invariant character recognition. Scaling is achieved by normalizing the features of the characters Translation is obtained using Center of Mass (COM). To obtain rotation invariance, RSC searches a rotation invariant Line of Reference (LOR) by exploiting the symmetric characters and Axis of Reference (AoR) for non symmetric characters. The RSC uses the LOR to produce topological features for different characters. The topological features are utilized as inputs for a multilayer feed-forward Artificial Neural Network (ANN) (Oh and Suen, 2002).

A novel algorithm is proposed to obtain the affine transformation knowledge of basic elements. Location invariant and Scale invariant are the basic element and Chinese character image extracting the SIFT features and the identical points of the two images are determined rendering to the standard principle of minimum Euclidean distance of eigenvectors (Mingyou *et al*., 2009).

Freeman Chain Code (FCC) as the representation system of an image character. Chain code gives the limit of a character image in which the codes speak to the course of where is the area of the following pixel. Randomized algorithm is utilized to create the FCC. The criteria of peculiarities to enter the classification is the chain code that changed over to different features. Furthermore, the genetic algorithm is connected to assess the initial populace to figure out the non-linear segmentation path and conceivable segmentation zone and Support Vector Machine (SVM) is selected for the classification step.

MATERIALS AND MEHTODS

The recognition system model: A typical off line handwriting recognition method consists of neural network structure using multi layer feed forward network with back propagation algorithm. The output from one layer feeds forward into the next layer of neurons and nodes between two layers are completely connected with numerous weights. The error is calculated by the alteration of outputs from output layer and target outputs. Then errors are feed backward to adjust weights which are then functional to the next iteration to generate new network outputs. The network outputs are applied to the ICR software. Typical off-line character recognition system is shown in Fig. 1.

Image acquisition: In image acquisition, the recognition system obtains a scanned image as an input image. The image should have a specific format such as BMT, JPEG, etc. This image is acquired through a scanner or any other appropriate digital input device (Verma and Kaur, 2014).

Preprocessing: The pre-processing is a series of operations performed on scanned input image. It essentially enhances the image, rendering it suitable for segmentation. Deskewing is utilized to make the baseline of the handwritten word in a horizontal or vertical direction by rotating the word in a suitable angle by a suitable direction. Scaling is necessary to produce characters of qualified size. Contour smoothing is a technique to remove contour noise (Lazzaro *et al*., 2013). The objective of contour smoothing is broken the noisy skewness input characters. Skewness refers to a bit mapped image of the scanned study for intelligent character recognition system.

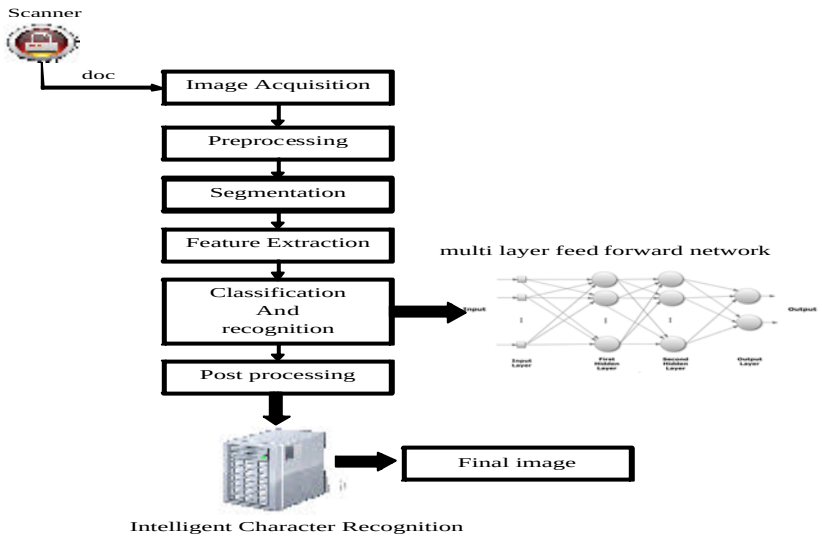

Fig. 1: Typical off-line character recognition system

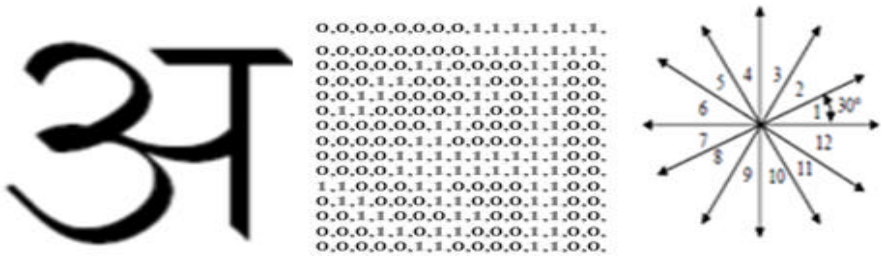

Fig. 2: Binary representation of character 'A' and directional feature extraction

Segmentation: It is a segmentation operation that seeks to decompose an image of a classification (sequence) of characters into sub images of specific symbols. Character segmentation is a key requirement that determines the utility of conventional character recognition systems. It includes the line, word and character segmentation. Character segmentation using horizontal and vertical segmentation technique (Shinde and Chougule, 2012; Patel *et al*., 2013). It also can determine the number of words in a specific line.

Feature extraction: The feature extraction methods for handwritten character recognition are based on two types of features are statistical and structural. This method used for conventional feature extraction and directional features extraction. Conventional method, work with line passes through a pixel which is foregrounded image this pixel will be given value is one, otherwise it is taken as zero which is a background image. In directional feature extraction the extracting the image in horizontal and vertical directions. The 12 directional values are shown in Fig. 2.

Extracts the information on the characters utilizing thresholding and thinning. Thresholding reduces the requirements and increases the rate of processing by converting the color images or grayscale to binary image by taking a threshold value. Thinning extracts the shape information of the characters.

Neural network architecture for recognition process: The network structure utilized a multi layer feed forward network with a back propagation algorithm. The output from onelayer feed into the next layer of neurons and nodes between two layers are fully connected with various weights. The error is calculated by the difference of outputs from outputlayer and target output then errors are feed backward to adjust weights which are then applied to the next iteration togenerate new network outputs. Multi layer feed forward network as shown in Fig. 3.

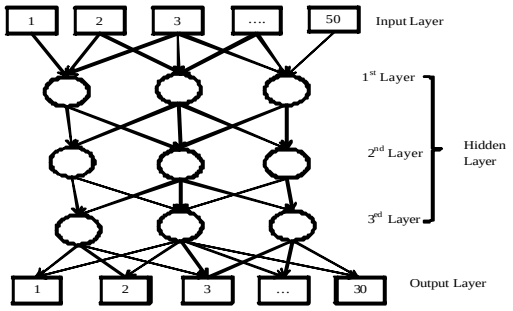

Fig. 3: Multi layer feed forward network

Input layer: Data sets in this study is formatted image pixels with 0 indicating a background image pixel and 1indicating a foregrounded image pixel. There is an additional 12 digit vector identifying the real identity of this character.

Hidden layer: Hidden layer is nothing but the set of nodes that are not input or output units. Neural network with only three hidden layers can represent linear functions.

Output layer: According to the requirement of character classification target, 30 output layer sequence representing each character. For example, the Sanskrit character is represented by [0 0 0 0 0 0 00 1111111] with the first pixel digit valued 1 and the rest the pixel values is to be 0. This is also consistent with the defined way the given data sets do to represent characters.

Backpropagation algorithm: A learning algorithm for multi-layered feed forward networks that use the sigmoid function. One specific detail in updating weights after training process is stopped, last iteration's weights should be stored as neural network weights because the last iteration's weights having the lowest error.

Step 1; initialization: Assuming that no prior information exists, the induced local fields of the neurons lie in the changeover between the saturated parts and linear of the sigmoid activation function.

Step 2; training examples: Present the network with an epoch of training examples. For such example in the set ordered in some fashion, perform the sequence of forward and backward computations.

Step 3; forward computation: Let a training example in the epoch be represented by (x(n), d(n)) with the input vector x(n) is applied to the input layer of sensual nodes and the preferred response vector d(n) access to the output layer of the computation nodes. The induced local field $v_j(n)$ for neuron j in layer l is:

$$v_j(n) = \sum w_{ji}(n) y_i(n) \quad (1)$$

Where:

y_i = The output signal of neuron i in the previous layer l-1 at iteration

n and $w_{ji}(n)$ = The synaptic weight of neuron j in layer

Assuming the utilization of a sigmoid function, the output signal of neuron j in layer 1 is:

$$y_j = \varphi(v_j(n)) \quad (2)$$

If neuron j is in the first hidden layer set:

$$y_j = O_j(n) \quad (3)$$

Compute the error signal:

$$e_j(n) = d_j(n) - o_j(n) \quad (4)$$

where $d_j(n)$ is the j element of desired response vector d(n).

Step 4; backward computation: Compute the δ_j of the network denoted by:

$$\delta_j = e_j(n)\varphi'(v_j(n)) \text{ for neuron j in output layer L}$$
$$\delta_j(n) = \varphi'(v_j(n))\sum \delta_k(n) w_{kj}(n) \quad (5)$$

Where, the prime in $\varphi'(.)$ refer differentiation with respect to the argument. Adjust the synaptic weights of the network in layer 1 according to the generalized delta rule:

$$w_{ji}(n+1) = w_{ji}(n) + \propto [w_{ji}(n-1) + \eta\delta_j(n)y_j(n)] \quad (6)$$

where η is the learning rate parameter and a is the momentum constant.

Step 5; iteration: Iterate the backward and forward computations under step 3 and 4 by getting new epochs of training samples to the network until the stopping measure is met.

Post processing: Post-processing stage is the final stage of the proposed recognition system. It prints the corresponding recognized characters in the structured text form using recognition index of the test samples.

Intelligent character recognition: The computer system where the ICR system has recognition of characters using scanned images. These characters are classified as mismatched, highly mismatched, matched character and undecided character (Fig. 4).

To this end, a novel method is proposed towards the recognition of large collections of text images using a

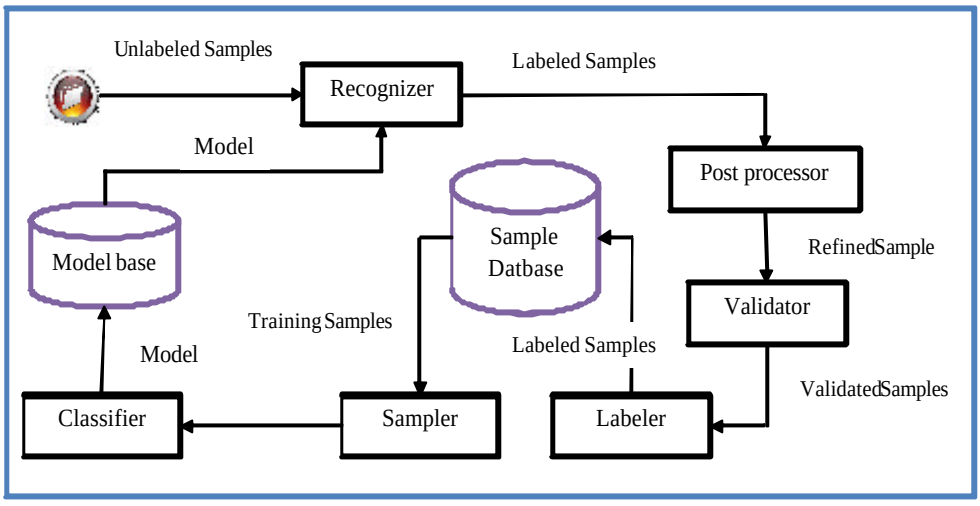

Fig. 4: An architecture of the ICR learning framework in the recognition of the document

multilayer feed forward mechanism. In this study presents the ICR system that increases its performance incessantly across a huge collection of document images through a multi layer feed forward mechanism. The strategy of designing this framework is with the goal of enabling the ICR learn to utilizingthe knowledge derived from an input of images. The resulting system is predictable to learn the characteristics of context, symbol, shape and noises that are present in a pool of images in the quantity (corpus) and thus should be capable to simplify and achieve higher accuracy acrossvaried documents.

RESULTS AND DISCUSSION

The MATLAB tool is used in this research. The MATLAB tool is used to build the simulation environment and the proposed techniques are simulated to evaluate the performance of character recognition. The experiment has been done to observe two things: the behavior of the multilayer feed forward neural network and the character recognition accuracy rate. The behavior of the network has been monitoring with respect to various parameters (learning rate, hidden unit) used in the proposed multi layer feed forward neural network model.

Network setup: Before implementing the designed network in intelligent character recognition system, it has been tested using sample data. For this purpose, a simple train set has been created which denotes an image. The network has been learnt with a pattern where the test pattern set is same as the train set. The network learns all the patterns in a few iterations and successfully classify them. The network setup as shown as Table 1.

Character recognition accuracy rate: Total 10 fold cross validation is applied for recognition accuracy rate. A K-fold partition of the data set is created. For each K trial, K-1 folds are utilized for training and the remaining one for testing as shown in Fig.5, the average error across all K fold is computed as follows:

$$E = \frac{1}{k}\sum_{i=1}^{k} E_i \qquad (7)$$

Two types of recognition errors in ICR system substitution errors which is erroneously recognized characters and rejected errors which is unrecognized characters. The measure is the rejection rate:

$$G_{rej} = 100\,\frac{n_r}{n_c} \qquad (8)$$

Table 1: Network setup

MLFF	
Image	JPEG, etc
Input	50
10 neurons	1st hidden layer
10 neurons	2nd hidden layer
10 neurons	3rd hidden layer
30 neurons	No. of output neurons
Trained and tested method	10-fold cross-validation
Termination conditions	Based on minimum mean square error or maximum number of epochs allowed
Transfer function	Linear
Maximum epochs	2000
Back-propagation learning rate	0.1
Learning rate parameter	0.01

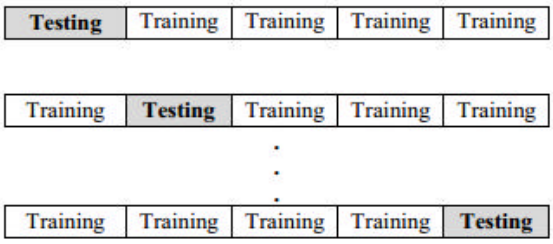

Fig. 5: The K-fold cross validation of the dataset

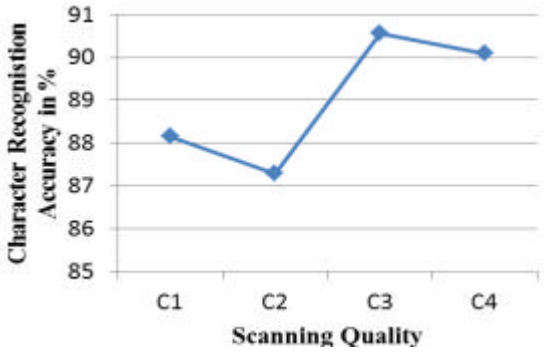

Fig. 6: Effect of scanning quality on recognition accuracy level of "ICR" system

Where:

n_c = No. of all characters in the text

n_r = No. of rejections

Performance evaluation: To analyze the effect of image quality on the character recognition level of "ICR" system, four cases (C1-4) were designed using different scanning parameters where C1 (128 units), C2 (184 Units), C3 (128 units) and C4 (144 units) are default values, "C" refers to contrast values for ICR image. Figure 6 shows the effect of scanning parameters on different errors types using "ICR" system.

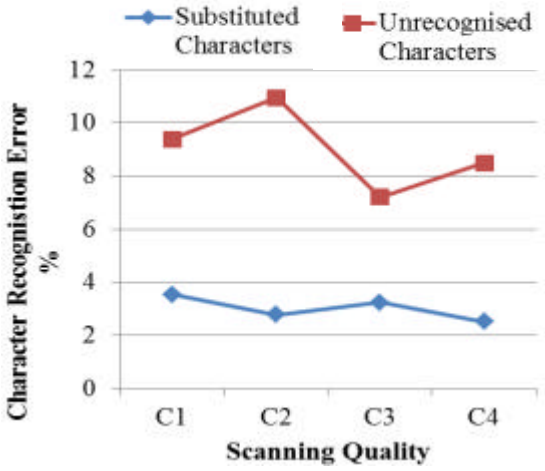

Fig. 7: Effect of scanning quality on different errors

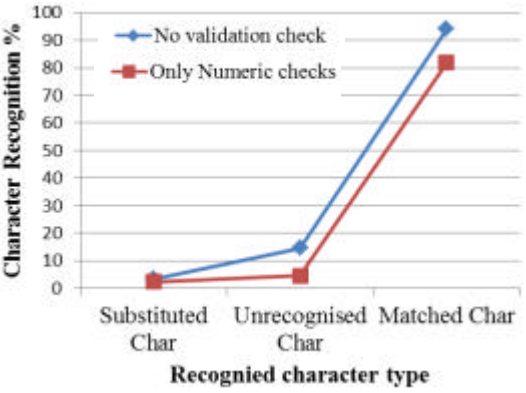

Fig. 8: Effect of data validation checks on recognition accuracy level of ICR system

Figure 7 shows the effect of scanning parameters on dissimilar errors types using "ICR" system. The highest error rate (10.95%) for unrecognized characters is for the C2 images and lowest rate (7.22%) for C1 images. Likewise, highest changeover character error rate (3.54%) for the C1 images where as lowest changeover character error rate (2.52%) for C2 images. This indicates that contrast values are required to improve the character recognition level of "ICR" system.

Data validation checks affect the recognition accuracy of ICR system. Utilizing various data validation checks can provide high data accuracy and able to minimize human intervention. Figure 8 shows the outcome of data validation checks in recognition accuracy level of ICR system.

CONCLUSION

Offline handwritten character recognition is a difficult problem, not only because of the great amount of variations in human handwriting, but also, because of the joined characters overlapped characters.Recognition methods depend on the nature of the data to be recognized. Since, handwritten characters could be of various sizes and shapes, the recognition procedure needs to be much accurate and efficient to recognize the characters written by different type of users. As multilayer feed forward neural network and ICR is utilized here for recognition of offline character recognition. The proposed work can be trained with more patterns of the character. So, to increase the system performance, the horizontal and vertical segmentation technique can be improved to deal with composite characters. The recognized scanned image shows a high quality to reduce the complexities in the recognition process. This character recognition approach shows a better result in terms of accuracy and speed.

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