Handwritten Devanagri Numeral Character Recognition using SVN and ANN

Arjun Singh
Assiatant Professor
BBAU Satellite Campus, Amethi

Abstract— Handwritten numeral character recognition is one of the most challenging processes. It also have diverse applicable environment. This paper proposed a system for recognizing offline Handwritten Devanagari numeral character recognition using Support Vector Machine and Artificial Neural Network, both techniques are used as classifier and results are compared. We apply various techniques for image enhancement which are useful to improve the accuracy of the recognition of numeral character such as binarization, noise removable and normalization. Extracting the feature of numeral character we have used statistical and structured based feature of numeral character. We have used Chain Code, Zone Based Centroid, Background Directional Distribution and Distance Profile features feature extraction techniques. We also discussed the segmentation process used in this process. Experiment is carried out by varying the image sizes: 30x30, 40x40, and 50x50 using MATLAB on more than 5,000 samples. The overall recognition accuracy is 99.20 % by using SVM and 98.12 by using ANN.

Key words: Optical Character Recognition (OCR), Support Vector Machine (SVM), Artificial Neural Network (ANN), Binarization, Feature Extraction

I. INTRODUCTION

Old literature such as handwritten documents, manuscripts and books are used as one of main source of acquiring knowledge[1]. With the advent of printing machines magazines, news paper and printed books became the new main source of acquiring knowledge. In modern age whole scenario changed people would like to keep the information in digital format. It is cheap, portable and fastest way to store the information. While many of the important literature, books, and other documents are written form. Some documents are very rare which are not easily available for the general people because of that many organization and libraries around the world take the decision to convert the written document to digital document. Converting information from written document to digital format is challenging task because a lot of noise, missing character and distorted character of scripts. Scanning written documents is not good solution to digitizing documents because it requires a huge amount of memory space. Hence optical character recognition system is required so that written information can easily convert in digital information.

Table 1: Devanagri Numerals Handwritten samples for dataset

II. PROPOSED SYSTEM ARCHITECTURE

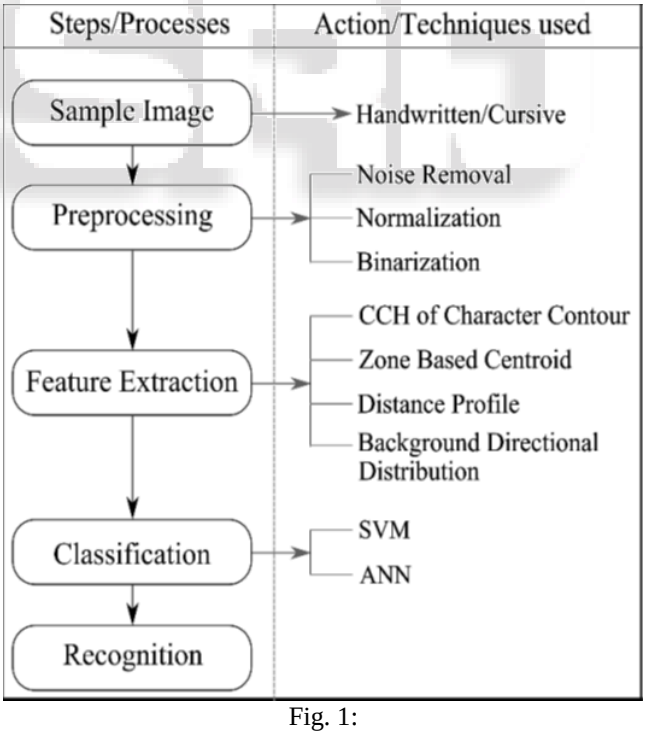


Fig. 1:

A. *Pre-Processing:*

Pre-processing is a series of operations which are performed to enhance the image quality. It is essential to enhance the image feature for better results. The techniques used to enhance the image are described below:

B. *Noise Removal:*

During writing, noise may be introduced due to any writing mistakes or disturbance. When images is scanned, some

scanning devices also introduced noises like filled loops, disconnected lines, bumps and gaps in line of characters [2]. Removing the noise is necessary to reorganization purpose.

C. Normalization:

This is essential part of character recognition in preprocessing phase which attempt to remove variations in images so that image will not be able to change identity of character [3]. Normalization gives the proper shapes to the images so that feature of the character images can be compared. Basically it deals with sizes of the images. In this paper three different image sizes viz., 30x30, 40x40, and 50x50 are used and accuracies are compared..

D. Binarization:

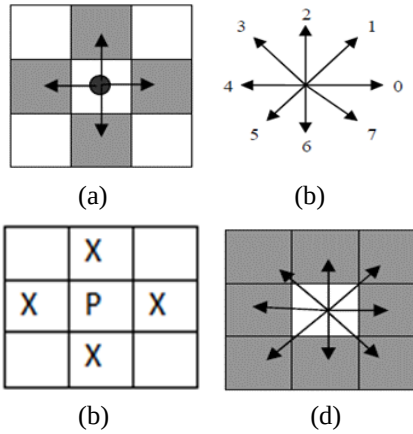
After Normalization of image the gray level image is converted into binary form so as to ease analyze the behavior character [4]. Binarization converted gray scaled image into binary image where 0 shows black pixels and 1 shows white pixels. Global thresholding picks one threshold value for the entire document image based on an estimation of the background level from the intensity histogram of the image. In this paper global thresholding technique, Otsu‟s method is applied to binarize the images.

III. FEATURE EXTRACTION

In this section, we discuss the feature extraction method used by the classifier. These techniques are applied after image pre-processing and the recognition accuracy of the system depends upon the feature extraction techniques. The four feature extraction techniques used in this paper are described below:

A. Chain Code Histogram of Character Contour:

This coding approach shows the direction of the next pixel in the image. Given a scaled image of handwritten character, we applied contour points method to the image and got contour of the scaled image. We have taken a 3×3 window which surrounded by the all object points of the image. If any of the 4-connected neighbor points is a background point then the object point (P), as shown in Figure 3.1 is considered as contour point.



(a) (b)

(b) (d)

Fig. 1: Chain Coding: (a) 4-connectivity, (b) 8-connectivity. (c) P is the processed element in Chain coding for feature. (d) Direction of connectivity, Generate the chain code by detecting the direction of the next-in-line pixel

The contour following procedure is used to trace the contour and a contour representation called “chain coding” as proposed by Freeman [5], shown in figure 1(b). Each pixel of the contour is assigned a different code that indicates the direction of the next pixel that belongs to the contour in some given direction[6]. It provides the points which are related to one another position , these points are independent of the coordinate system.

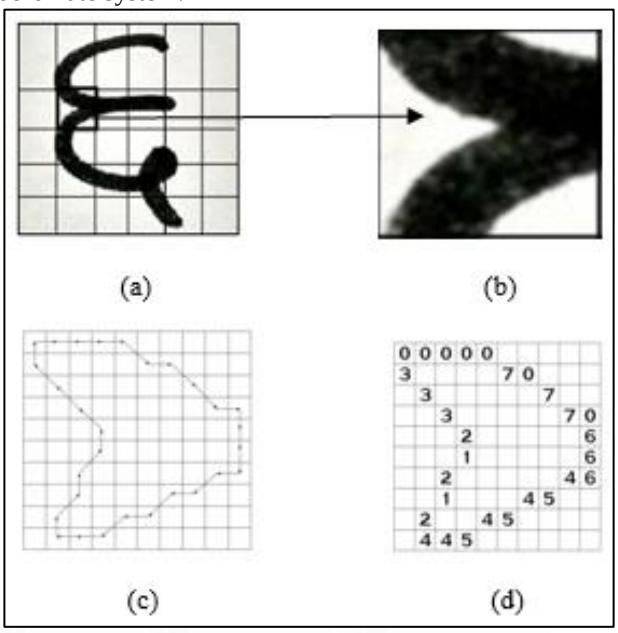


Fig. 2. (a) character image is divided into 5x5 image block. (b) block of image corresponding to character. (c) Chain code process and (d) chain code corresponding to block.

This method is used to connecting all neighboring contour pixels; points and outline coding are captured in this process. Contour following procedure may proceed in clockwise or in counter clockwise direction. We have chosen to proceed in a clockwise direction. The contour image is divided into 5 × 5 blocks as shown in figure 2 (a). In each of these blocks, each block is 10x10 sizes and applying the chain coding process and darkest spot is show the starting and ending point of chain code as shown in figure 2 (b) and (c). Finally we get the chain code of the image as shown in figure 2 (d). The frequency of the direction code is computed and a histogram of chain code is prepared for each block. Thus for 5 × 5 blocks we get 5 × 5 × 8 = 200 features for recognition.

B. Zone Based Centroid Feature:

This method gives better result even certain preprocessing processes like smoothing, filtering, and skew detection are not considered. This is easy method for implementation and major advantage of this approach for its robustness for small variation. The character image centroid is computed and character image (50x50) is divided into 25 equal zones (10x10). Zone centroid is computed in each zone.

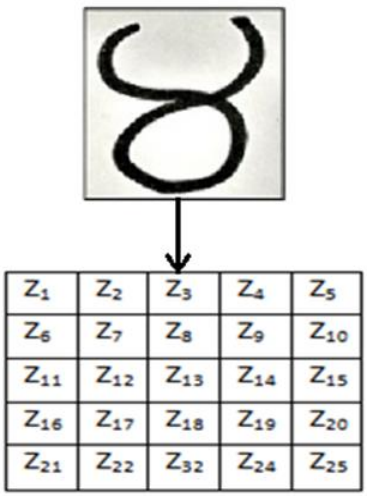


Fig. 3: Character image is divied into into 5x5 zones

This process is repeated for all 25 zones of image[7]. Figure 3 images is divided into 5x5 block and centroid of each is calculated which is the feature of block in this way f1, f2, f3….f25 features are computed.It could be possible that some zone have empty foreground pixels. Hence that zone is assigned by zero. Distance of each zone centroids with image centroid is computed.

C. Distance Profile Features:

In this technique, profile computes the distance (pixels) from bounding box of character image to outer image of character. The distance is traced horizontal and vertical[8]. We used four profiles of the character which are left, right, bottom and top. Left profiles are computed by traversing horizontally in forward direction and right profiles are computed by traversing backward direction. Similarly, we computed top and bottom profiles by traversing downward and upward direction from top and bottom bounding box. All these profiles show pixels in background and foreground of the image. We normalized dataset to 50x50, distance profiles consists 200 features.

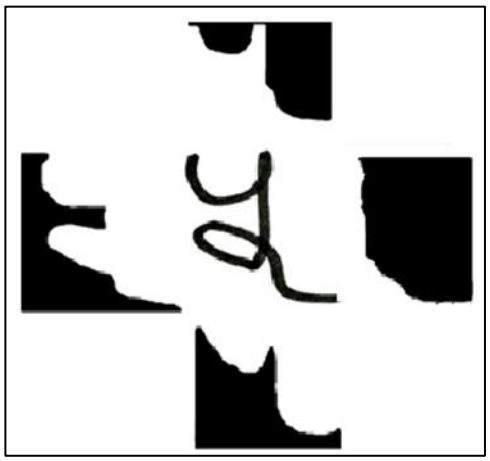


Fig. 4: shows the distance profile features

D. Background Directional Distribution Features:

This approach maximizes the discriminative power of the distance features and investigates the rich description of patterns. Directional distances in 8 directions are computed by pixels and both white and black pixels are computed[9].

Fig. 5: Chracter image is divided into 10x10 zones for computing the directional features.

We used mask to computing the directional distribution values as shown in figure 6(c). Pixel 'P' is considered as foreground pixels for computing the directional distribution in each direction.To explain the working of BDD features, we computed directional distribution value for foreground pixel 'P' in direction d5 as shown in figure 6(c). mask of d5 is superimpose on the sample image which is coinciding at centered pixels 'P'. d5 mask values is coinciding to background pixel neighbor 'P' as shown in figure 6(c). i.e. d5 and d4 (i.e. 1+2) will ne feature values for in direction d5. In this way we computed the mask value in each direction and then sum all these values in each zone. Each zone comprises total 200 features values for sample image.

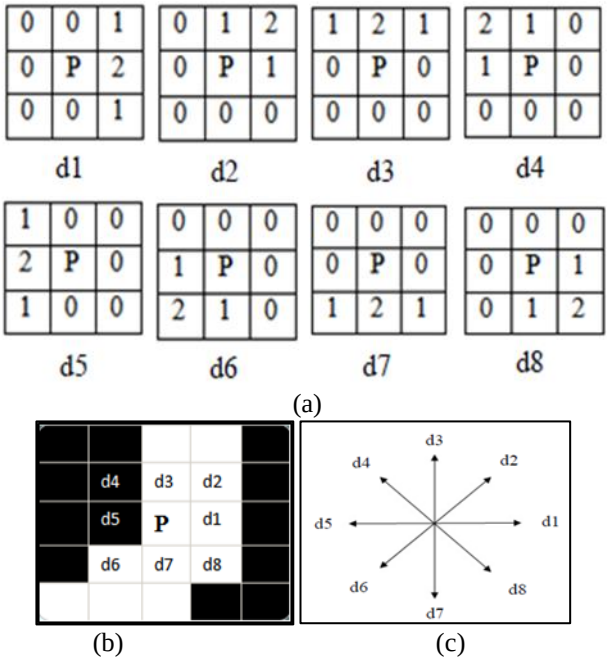


Fig. 6: (a) 8 directions used to compute directional distribution, (b) Masks used to compute directional distribution in different directions. (c) An example of sample.

IV. RESULTS

Handwritten Devanagari numerals sets are taken. These steps are followed to obtain best accuracy of input handwritten Hindi Numerals image. First of all, training of system is done by using different data set or sample, then system is tested for few of the given sample, and accuracy is measured. The data set are partitioned into two parts. The first part is used for training the system and the second are for testing purpose. For each character, feature are computed and stored for training the network and SVM model [10,11].

To obtain the recognition results, ANN and SVM are used to recognize the numerals. Results are obtained for Devanagari numerals on their respective datasets comprising of 5,000 sample images respectively. We take 400 character for training and 100 characters for testing purpose when SVM technique is used to recognize the Numerals. In case of ANN distribution, 80% for training, 5% for validation and 15% are to simulate the network. The neural network is trained and retrained to get the best results. We work also on different sizes of images such as 30x03, 40x40 and 50x50 while corresponding feature vector size is 413,517 and 625 respectively, to get the best result and these results are compared. The best result, 99.2 % is observed for SVM. In table 2 we show results that are achieved in the experiment at different sizes of images. When the size of the image is reduced, number of features also reduces here. Table 5.1 show results obtained for different size of images by ANN and SVM.

Size of Image	No, of Features	ANN	SVM
30x30	413	97.52	99.20
40x40	517	97.66	99.10
50x50	625	98.12	98.70

Table 2: Devanagari Numeral Character Recognition accuracy.

V. CONCLUSION

Support vector machine gives better classification accuracy as compared to artificial neural network for recognition of handwritten devanagri numeral character recognition. In this experiment we have uesd chanin code, zone based centroid, distance profile and background direct distribution feature extraction techniques. These features are appied to ANN and SVM classifier for classification for better result. In future we will work on other methods of feature extraction to improve accuracy for recognition purpose.

REFERENCES

[1] I.K. Sethi and B. Chatterjee, “Machine recognition of constrained handprinted Devanagari”. Pattern Recognition, Vol. 9, 1977, pp.69-75.
[2] Fan, Kuo-Chin, Yuan-Kai Wang, and Tsann-Ran Lay. "Marginal noise removal of document images." Pattern Recognition 35.11 pp 2593-2611, 2002.
[3] Liu, Cheng-Lin, and Katsumi Marukawa. "Pseudo two-dimensional shape normalization methods for handwritten Chinese character recognition." Pattern Recognition 38.12 pp 2242-2255, 2005.
[4] Yang, Feng, Zheng Ma, and Mei Xie. "A novel binarization approach for license plate." In Industrial Electronics and Applications, 2006 1ST IEEE Conference on, pp. 1-4. IEEE, 2006.
[5] Freeman, Herbert, and Ruth Shapira. "Determining the minimumarea encasing rectangle for an arbitrary closed curve." Communications of the ACM 18.7, pp 409-413, 1975.
[6] Suliman, Azizah, MohdNasirSulaiman, Mohamed Othman, and RahmitaWirza. "Chain Coding and Pre Processing Stages of Handwritten Character Image File." electronic Journal of Computer Science and Information Technology 2, no. 1 (2011).
[7] Shaffie, Ahmed M., and Galal A. Elkobrosy. "A Fast Recognition System for Isolated Printed Characters Using Center of Gravity and Principal Axis." Applied Mathematics 4 (2013): 1313
[8] Siddharth, Kartar Singh, Renu Dhir, and Rajneesh Rani. "Comparative Recognition of Handwritten Gurmukhi Numerals Using Different Feature Sets and Classifiers." Proceedings of International Conference on Image Information Processing (ICIIP 2011). 2011.
[9] Siddharth, Kartar Singh, Renu Dhir, and Rajneesh Rani. "Handwritten Gurmukhi Character Recognition Using Zoning Density and Background Directional Distribution Features." International Journal of Computer Science and Information Technologies 2.3 (2011): 1036-1041.
[10] Shailendra Kumar Shrivastava Pratibha Chaurasia Handwritten Devanagari Lipi using Support Vector Machine International Journal of Computer Applications (0975 – 8887) Volume 43– No.20, April 2012
[11] Shubhangi D.C., P. S. Hiremath, “Multi-Class SVM Classifier for English Handwritten Digit Recognition using Manual Class Segmentation”, Proc. Int’l Conf. on Advances in Computing. Communication and Control (ICAC3’09) 2009, pp. 353-356.

