

Analysis on Handwritten Bangla Character Recognition Using ANN

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Abstract— Bangla handwritten character recognition is one of the complex works because of the wide variation of the Bangla character. In this paper we proposed a new approach for extracting the features of Bangla handwritten characters and then recognition of those characters using artificial neural network has done. For the feature extraction process we have used a row and column basis segmentation process in which a binary image the ratio of the dispersion of black from the top of the segment and total number of column or row pixels is measured on that particular segment as well as for each segment and then from this data a feature matrix of $M \times 1$ dimension is created for each character. When features from all the characters are extracted then some of the data is used to train the feed forward neural network and after that some characters are used for testing. In our proposed method 94.3% recognition accuracy is obtained when tested on some handwritten Bangla characters.

Keywords—*Handwritten Bangla character; character segmentation; recognition; artificial neural network*

I. INTRODUCTION

Character recognition is a process through which a character can be identified automatically. Due to the complexity and variations of Bangla handwritten characters, recognition of Bangla characters is now a great interest for the researchers. The detection of handwritten character is a difficult and challenging task in many real world applications [1]. In previous years there has been many work done to detect the characters [2]-[4]. In literature, there exist English, Chinese, Roman and Arabic numeral recognition process [5]-[7]. For the detection of Bangla character do not have so much work till now. Some work is done for the detection of printed Bangla characters [8], [9]. Bangla handwritten character recognition is very difficult because of the wide variation in the individual writing style. So to improve the accuracy of Bangla handwritten character recognition there must need to improve the feature extraction process. A work is done using the gradient information and haar wavelet transform for the purpose of detection of handwritten character in machine printed form [10]. Also Bangla handwritten digit recognition is done using supervised locally linear embedding algorithm and support vector machine [11]. All the different work shows different accuracy and by changing the way of recognition is to increase the accuracy. Machine learning is a scientific discipline that automatically learns to recognize complex patterns and make intelligent decisions based on data [12]. For the purpose of

recognizing the handwritten characters artificial neural network (ANN) is used here. Artificial neural network is a computational model that tries to simulate the structure and functional aspects of biological neural networks [13]. ANN is used to train the network with the features which is extracted from the handwritten characters and then some character data is used to test the network. Here Backpropagation algorithm is used for this purpose. BP algorithm is a supervised learning technique used for training Multi-Layer Perceptrons (MLPs) [14].

In this paper we proposed a new method of feature extraction for the purpose of recognizing Bangla handwritten characters. This feature extraction process is simpler than many other extracting methods with better accuracy. Because of the simplicity of our feature extraction method the character detection is fast. First we have applied a method through which the connected component from a set of character data is detected. So by this applied method each individual character is detected. Then each single character image is processed in a way so that some important feature is extracted from that image and saved as database. This feature extraction process is based on the row and column segmentation procedure. Firstly the whole image is divided into four horizontal regions and then the image is also segmented into four vertical regions. Now for extracting the features from the binary image of the character for each segment of horizontal region, eight vertical lines is applied which trace the ratio of number of black pixels dispersed from the top and the total vertical pixels through the lines on that segment. And then through the segment the ratio of black and total vertical pixel values are taken as the desired data. The similar method is applied on the column segmented region where eight horizontal line tracing is used for the feature extraction. In this way a 64×1 feature matrix is produced. Then a feed forward neural network with BP algorithm is used for train the network and some data are used for the testing purpose. BP is used here because it is the most popular algorithm for ANN. In our proposed method the accuracy is higher and its detection process is almost perfect except some of the character.

The rest of the paper organized as follows. Section II briefly overviews of our proposed method. Section III describes the proposed algorithm. Experiments and result analysis are described in Section IV. The discussion and conclusion of this work is shown in Section V and Section VI.

II. PROPOSED METHOD

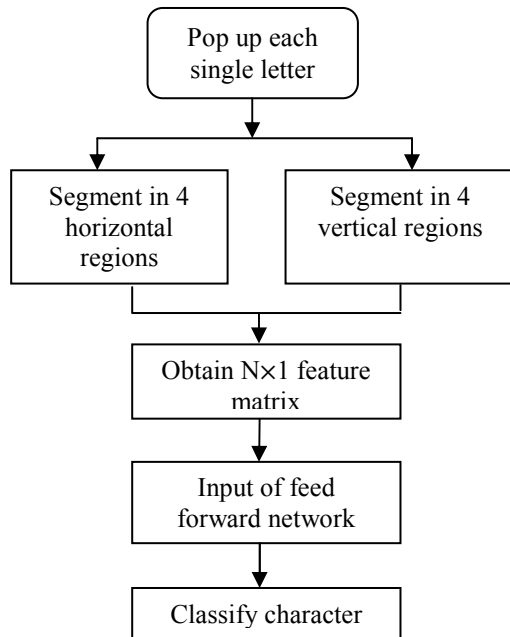


Figure 1. Block diagram of proposed method

Firstly we have observed the data by each character sorted from a given image. We have identified each character individually through the connected region of black portion of character. Then for each character we have applied segmentation in two sections. We have segmented each character in 4 horizontal and vertical sections. For each section of horizontal and vertical segmentation we have obtained 4×8 and 8×4 matrix respectively. Finally by combining those data we have obtained 64×1 matrix for our desired feed forward network. Obtained data is given to the input of feed forward network and by using this trained network we have classified characters.

III. ALGORITHM OF OUR PROPOSED METHOD

Step 1: A set of properties for each connected component (object) in the binary image. The image is a logical array; it should have minimum dimension.

Step 2: Segment the selected part of whole image in 4 horizontal regions (divide number of row by 4)

- Divide number of column by 8.
- Take only integer part from the division.
- On each selected column maximum distance of black portion from the top (for each row segment) has been taken and divided it by number of total rows on that row segment. Then this process is applied on all of the 8 vertical lines.

iv) Repeat same process for other horizontal segments.

Step 3: Segment the selected part of whole image in 4 vertical regions (divide number of column by 4)

- Divide number of row by 8.
- Take only integer part from the division.
- On each selected row maximum distance of black portion (for each column segment) has been taken and divided it by total number of columns on that column segment. Then this process is applied on all of the 8 horizontal lines.
- Repeat same process for other vertical segments.

Step 4: Put 64 point value on neural network input.

IV. EXPERIMENTAL STUDY

A. Feature Extraction

The feature extraction is very important section for recognition of Bangla characters. In order to obtain the database we have taken the hand written form of Bangla characters from 30 students. From which we have considered 20 student's data for the training dataset and 10 student's data for testing dataset. In case of feature extraction we have used an improved segmentation process to extract features for any handwritten Bangla character. Our segmentation process comprises of two sub-segmentation process. Firstly we define each character region in a single block through the connected region for each character and precede a row wise segmentation of four horizontal sections shown in Fig. 2(a). In each row section is then divided with eight vertical lines by which we calculate the ratio of dispersion of black region to total pixel values vertically for each line as well and finally obtain pixel value of 4×8 matrixes for each letter shown in Table I. For the vertical segmentation same process is applied to the character shown in Fig. 2(b) and obtain 8×4 and by transposing we set the value of vertical segmentation in same format 4×8 like horizontal segmentation shown in Table II.

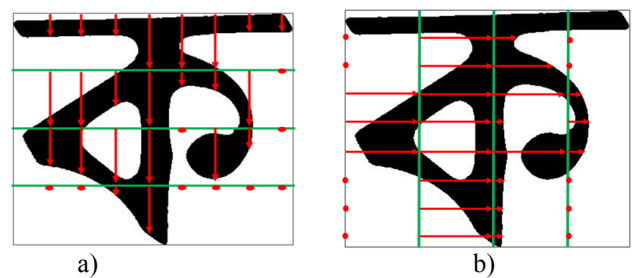


Figure 2. Feature extraction method a) horizontal segmentation b) vertical segmentation

B. Experimental Data

TABLE I. EXTRACTED FEATURES FROM HORIZONTAL SEGMENTATION

Input Node No 1-8	0.3875	0.375	0.3625	1	1	1	0.3125	0.3125
Input Node No 9-16	1	1	0.575	1	0.2625	0.3875	0	0
Input Node No 17-24	0.65	0.8125	1	1	1	0.8625	0	0
Input Node No 25-32	0	0	0.2073	0.8902	0	0	0	0

TABLE II. EXTRACTED FEATURES FROM VERTICAL SEGMENTATION

Input Node No 33-40	0	0	1	1	1	0	0	0
Input Node No 41-48	1	1	1	1	1	1	1	0
Input Node No 49-56	0.4124	0.9794	0.2681	0.2474	1	0.2475	0.2371	0.2165
Input Node No 57-64	0	0	0.3737	0.4444	0.3636	0	0	0

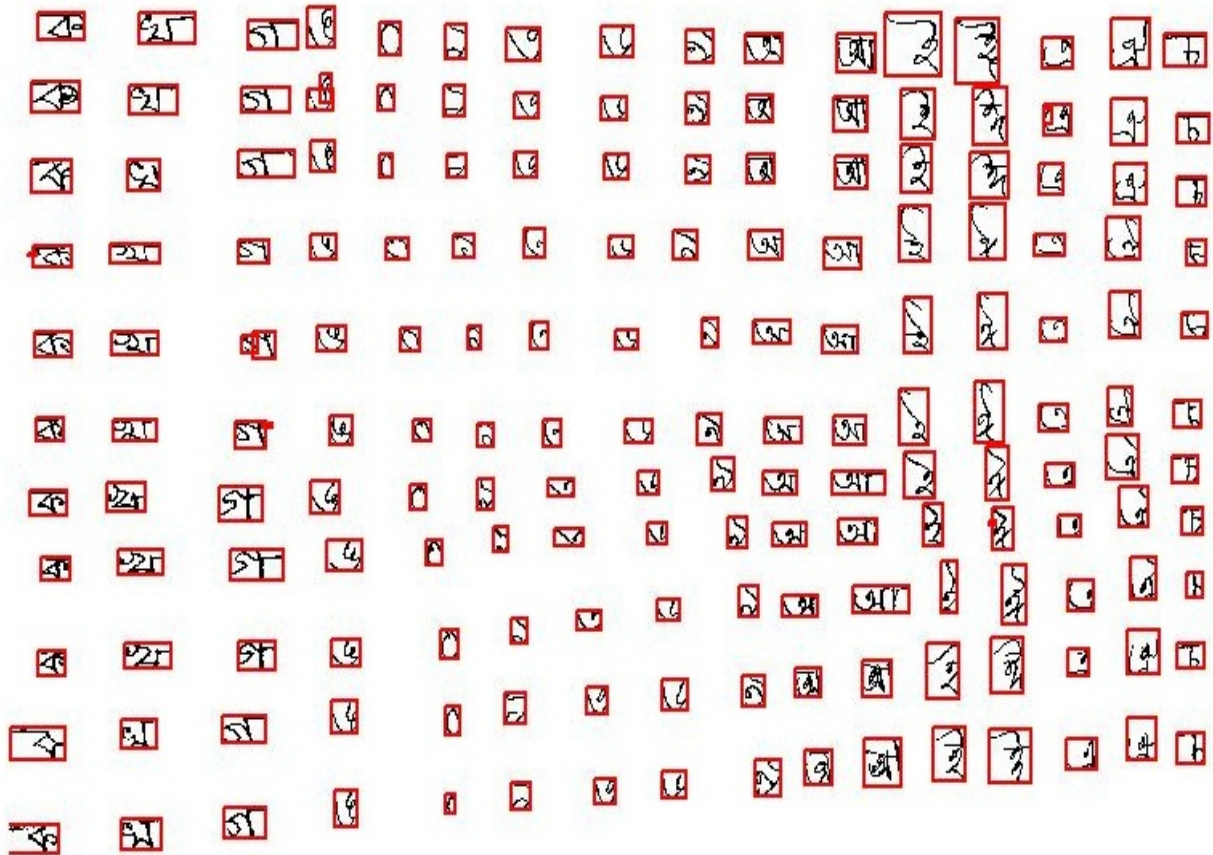


Figure 3. Different handwritten Bangla characters for training and testing

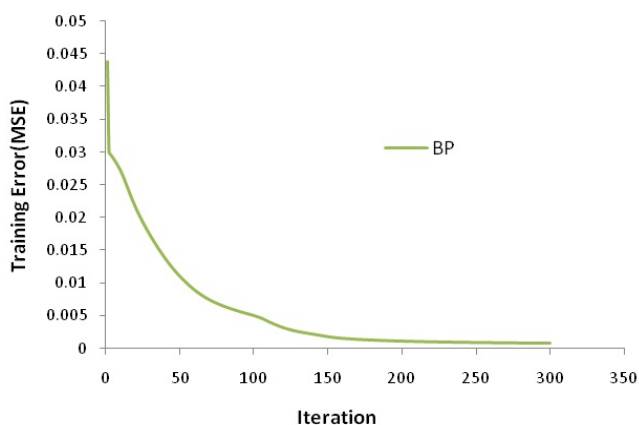


Figure 4. Training error vs no of iteration for Bangla handwritten character

From Fig. 3 we have taken the experimented handwritten Bangla characters which have been written by different writers naturally. We have distinguished each character by

defining a region which is interconnected. We took first ten different characters to the input of our neural networking system to train the network with those characters. According to Fig. 4 we have performed 300 iteration through backpropagation and optimized minimum training error point. From this curve we have defined a saturation point of minimum error of 0.003 at 150th iteration. We have optimized this point and used our 11th character data in the network input for testing with these characters.

Table III shows the experimental data for our Bangla handwritten characters. We have different Bangla alphabets or characters including Bangla numeric characters as well. For each Bangla character the recognition and classification rate is higher and some characters go through the rate of recognition near 100% like for '০' (96%), '৬' (94%) and '৯' (96%). But in case of '৩' the recognition rate falls below than others and our system cannot classify this character and for given input corresponds to this character our system classify '৩' as '৮'.

TABLE III. CONFUSION MATRIX FOR BANGLA HANDWRITTEN CHARACTER

Classes	ক	খ	গ	ঙ	০	১	২	৩	৪	৫	৬	৭	৮	৯	০	১
ক	0.73	0.004	0.0	0.013	0.22	0.032	0.094	0.021	0.023	0.001	0	0.008	0	0	0.002	0.05
খ	0.0	0.815	0.009	0.0	0.006	0	0.005	0.199	0.001	0.096	0.006	0.006	0.01	0	0	0.003
গ	0.001	0.044	0.687	0	0.002	0	0.008	0	0.039	0.006	0.01	0.005	0.033	0.021	0.002	0.001
ঙ	0.025	0	0	0.86	0.003	0	0	0.144	0.012	0.035	0	0.056	0.002	0.01	0.03	0.012
০	0.002	0.081	0.002	0	0.96	0.008	0.063	0.024	0.024	0.071	0	0.001	0	0	0	0.011
১	0.008	0	0	0.001	0.012	0.77	0.006	0	0.35	0.002	0.021	0	0.002	0.01	0.001	0.005
২	0.01	0.008	0.001	0.001	0.13	0.006	0.89	0.03	0.025	0	0	0.001	0	0.062	0.005	0
৩	0.005	0.001	0	0.092	0.006	0	0.01	0.94	0.001	0.033	0	0.04	0	0.001	0.07	0
৪	0.20	0	0	0.004	0	0.38	0.007	0	0.58	0.002	0.104	0	0.002	0	0.031	0.007
৫	0.005	0.001	0.004	0.39	0.001	0	0	0.007	0.058	0.787	0.003	0.022	0.006	0	0.003	0.02
৬	0.007	0.006	0.10	0.001	0	0.001	0	0	0.036	0.05	0.819	0.001	0.015	0.001	0.001	0
৭	0.002	0.002	0.001	0.007	0.001	0	0	0.008	0	0.013	0.002	0.85	0.07	0.001	0.01	0.01
৮	0.018	0.424	0	0	0.145	0.02	0.007	0.006	0.022	0.036	0	0.014	0.11	0	0	0.87
৯	0.001	0	0.12	0.011	0.008	0.015	0.064	0.01	0.05	0	0.005	0.001	0.004	0.981	0.035	0
০	0.01	0	0.001	0.002	0	0.003	0.015	0.012	0.002	0	0.013	0.033	0.097	0.03	0.96	0
১	0.005	0.065	0.007	0.002	0.184	0.007	0.002	0.002	0.03	0.007	0	0.019	0.002	0	0	0.86

V. DISCUSSION

Bangla scripts are moderately complex than most of language scripts with its specifications as well as lots of variations in each letter. It would be very easy to extract feature and classify the characters for printed version but in case of handwritten it arises more complexity for feature extraction as well as classification. In application of Smartphone the search option in free hand written form of Bangla character can be easily detected which is compatible to users. For real life application Bangla characters need to be distinguishable identically. In most recent methods have provided better feature extraction or separation of characters but complete classification or identification for maximum accuracy is still needed for better performance of versatile applications. In our method the hand written bangla characters should be organized in a directional format or linearly placed. Any kind of non linearity or rotation of characters can cause error as well as misdetection. This can be considered as the limitation of this work and it can be modified with some additional features. We have also only detected characters individually but not in words or sentences. In this method we have used backpropagation algorithm through feed forward neural networking system which mainly classifies the Bangla characters for minimum errors with maximum recognition accuracy. Our proposed method shows less complex identification process to classify Bangla handwritten characters.

VI. CONCLUSION

Artificial neural network is massively used to perform nearly works as like data or feature extraction and recognition. This paper proposes new feature extraction process which is based on segmentation of row and column. In our method we have shown our feature extraction process by new extraction algorithm as well as we have used a system that would sustain our main purpose in order to classify and recognize the Bangla

characters. Besides these one of the most important matter of this method of working with handwritten characters through simplified process which is very applicable in our real life analysis. By using classifier the obtained recognition rate is 94.3% and our future modification will be reduction of some minimal errors.

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