



## Handwritten Bangla Character Recognition Using Neural Network

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**Abstract—** This paper presents an off-line recognition system for Bangla handwritten characters using Back-propagation Feed-forward neural network. Character is identified by analysing its shape and comparing its features that distinguishes each character. Also an analysis was carried out to determine the number of hidden layer nodes to achieve high performance of Back-propagation network in the recognition of handwritten Bangla characters. First, we try to create binary image. Then, extract the feature and form input vector. Then, apply the input vector in the neural network. The experimental result has analysed and result shows that the proposed recognition method gives 84% accuracy and less computational cost than other method.

**Keywords—** Bangla Character Recognition, Feature Extraction, Pre-processing, RGB image, Pixel grabbing, fed-forward neural network.

### I. INTRODUCTION

For Optical character recognition (OCR) is the translation of optically scanned bitmaps of printed or written text characters into character codes, such as ASCII. This is an efficient way to turn hard-copy materials into data files that can be edited and otherwise manipulated on a computer [1]. This is the technology long used by libraries and government agencies to make lengthy documents quickly available electronically. Advances in OCR technology have spurred its increasing use by enterprises. For many document-input tasks, OCR is the most cost-effective and speedy method available [2]. And each year, the technology frees acres of storage space once given over to file cabinets and boxes full of paper documents. Before OCR can be used, the source material must be scanned using an optical scanner (and sometimes a specialized circuit board in the PC) to read in the page as a bitmap (a pattern of dots) [3]. Software to recognize the images is also required. The OCR software then processes these scans to differentiate between images and text and determine what letters are represented in the light and dark areas. Older OCR systems match these images against stored bitmaps based on specific fonts. The hit-or-miss results of such pattern-recognition systems helped establish OCR's reputation for inaccuracy. Today's OCR engines add the multiple algorithms of neural network technology to analyze the stroke edge, the line of discontinuity between the text characters, and the background [4]. Allowing for irregularities of printed ink on paper, each algorithm averages the light and dark along the side of a stroke, matches it to known characters and makes a best guess as to which character it is. The OCR software then averages or polls the results from all the algorithms to obtain a single reading.

### II. OBJECTIVE

To presents a new technique for Handwritten Bangla Character Recognition system. Also reduce the recognition problem and the computational time. The aim of Bangla character recognition is to provide an efficient and accurate mechanism to recognize the handwritten bangle character. Our aim is to recognize 50 basic bangle characters using neural network.

### III. PROPOSED METHOD

The block diagram of our proposed model is given below:

#### A. Process of Character Recognition system

Basically we can divide whole process of Handwritten character Recognition system is two major parts:

1. Pre-processing and Feature Extraction.
2. Recognize with Neural network.

*A.1. Pre-processing and Feature Extraction*

Here, we have prepared the input image for feature extraction and then extract the feature of it. Using these features we have prepared an input matrix for Feed-forward neural network.

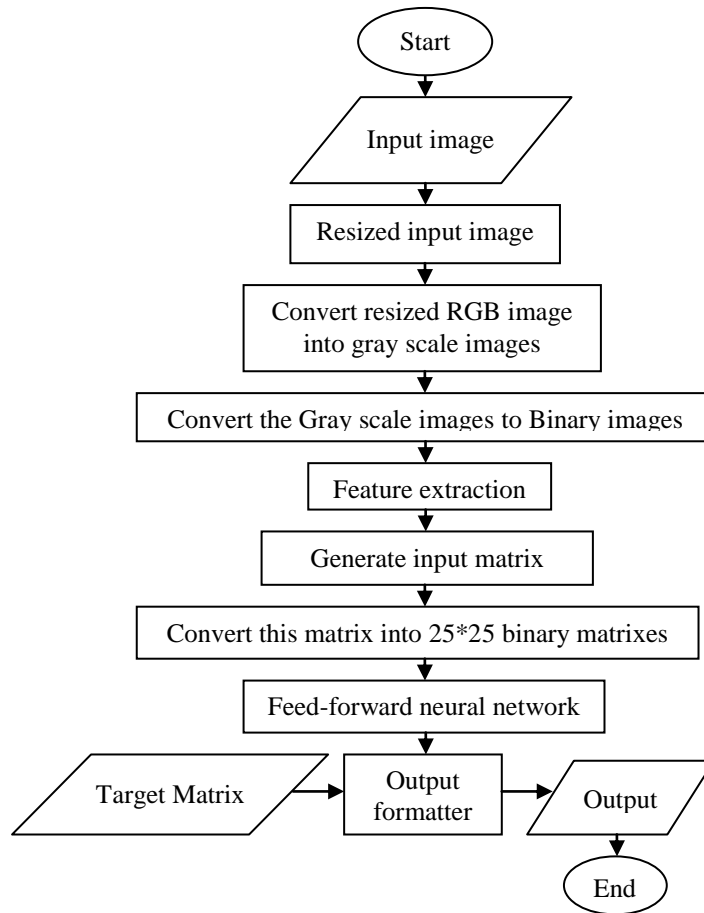


Fig. 1 Our proposed model

*A.1.1. Resizing the captured image*

Here the captured image size is so high i.e. high resolution. So, the size of the input image must be reduced. The reduction is done so carefully that the aspect ratio remains same. For example, if the size of an input image is 640×480 then the aspect ratio of it is 4/3. If we preserve the aspect ratio and try to reduce the size of the image, the output of this process may be 400×300 or, 300×225 or, 100×75 image [5]. We are very careful about the preservation of aspect ratio because if the aspect ratio is not preserved the shape of the image will change.

*A.1.2. RGB to Gray converter*

It is the process converts the resized RGB image into Gray scale image. We need to do this conversion because we need Binary image for operation and the Binary image can be constructed from Gray scale image by applying thresholding operation [6]. During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as "background" pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labelled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of "1" while a background pixel is given a value of "0." Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's labels.

*A.1.3. Gray scale to Binary image converter*

A binary image is a digital image that has only two possible values for each pixel. Typically the two colors used for a binary image are black and white though any two colors can be used. The color used for the object(s) in the image is the foreground color while the rest of the image is the background color. Thresholding method is used to separate object and background, which is divided image into two modes. The way to resolve both categories is by assigning a thresholding value T. Each point (x, y) which have value  $f(x, y) \leq T$  is called foreground object, and each point (x, y) which have value  $f(x, y) > T$  is called background object. A thresholded image  $g(x, y)$  is defined as,

$$g(x, y) = \begin{cases} 0; & \text{If } f(x, y) > T \\ 1; & \text{If } f(x, y) \leq T \end{cases}$$

Pixel which have value 1 correspond the object and pixel which have value 0 correspond background. T is a constants, this approach is called global thresholding.

*A.1.4. Feature extraction*

Next and the most important feature of Bangla character recognition is feature extraction. In this system I am considering a few steps for extracting a vector. Our main target is finding a vector from the image. So image is processed and then binary image is created [7]. So we have only 2 types of data on the image. Those are 1 for the white space and 0 for the black space. Now we have to pass the following steps for creating input vector for a particular character or image. Those are:

1. Pixel grabbing
2. Finding probability of making square

*A.1.4.1. Pixel grabbing from image*

As we are considering binary image and we also fixed the image size, so we can easily get 250 X 250 pixels from a particular image containing Bangla character or word. One thing is clear that we can grab and separate only character portion from the digital image. In specific, we took a Bangla character contained image. And obviously it's a binary image.

*A.1.4.2. Finding probability of making square*

Now we are going to sample the entire image into a specified portion so that we can get the vector easily. We specified an area of 25 X 25 pixels. For this we need to convert the 250 X 250 image into the 25 X 25 area. So for each sampled area we need to take 10 X 10 pixels from binary image. We can give a short example for that. Table 2 is the original binary image of 25 X 15 pixels. We need to sample it 5 X 3 pixels area. So, for each area we will consider 5 X 5 pixel from the binary image. Table 1 will show how pixels are classified for finding the probability of making square.

TABLE I  
INITIAL PIXEL AND SEPARATING THE PIXEL

Initial pixel data from image	Separating the pixels
00000110000010000000000000	00000 11000 00100 00000 00000
0000000000000000111000010	00000 00000 00000 01110 00010
0100000111001000111000100	01000 00111 00100 01110 00100
0010011111000100111000000	00100 11111 00010 01110 00000
0000000111000010000000000	00000 00111 00001 00000 00000
0111000000110001100100110	01110 00000 11000 11001 00110
0100000000011111001100000	01000 00000 01111 10011 00000
0011100000110001100100000	00111 00000 11000 11001 00000
0111100000001111001101110	01111 00000 00111 10011 01110
0001100000001111100100001	00011 00000 00111 11001 00001

*A.1.5. Target Matrix Generator*

We can easily generate the target matrix for feed-forward neural network. It is 50x 50 identity matrixes. The diagonal values are 1 and the value of remaining elements is 0. In each column there is only one element which the value is 1. It represents that the output neuron corresponding, this row number in on and other neurons are off. One output column is for input row.

*B. Recognized using neural network*

We have used feed-forward neural network. The neural network has three layers. The first layer takes input in of 25\*25 matrixes. The second layer is hidden layer. It consists of 10 neurons. The third layer is output layer. It consists of 50 neurons. These neurons are called output neurons. The number of neuron in the hidden is chosen so carefully that the performance of the neural network is maximized.

*C. Output Formatter*

The output formatter takes the output of the simulation as input and conversion it into human understandable form. For this it uses a thresholding process. It takes 0.5 as threshold value and converts the simulated matrix into 1 0 binary matrix. If the value of an element of simulated matrix is less than 0.5 it is set to 0, otherwise the value is set to 1 [8]. We can easily identify the output of corresponding input from this matrix. We can also calculate the recognition rate from the matrix. The formula is given below:

$$\text{Recognition rate} = (\text{number of 1's in the diagonal} / \text{total number of input}) \times 100\%$$

**IV. EXPERIMENTAL RESULTS**

We have used captured image for input image. We write down code on an M-file and execute it using MATLAB command prompt. Now we describe the experimental result in the following section of the input-output result.

*A. Implementation of Character recognition system*

The implementation of character recognition system, image acquisition and pre-treatment is the primary step of our implementation. The result of this step is given in the following description.

*A.1. Captured image*

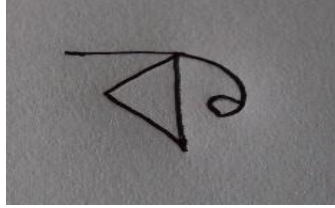


Fig. 2 Captured image

*A.2. Input Image*

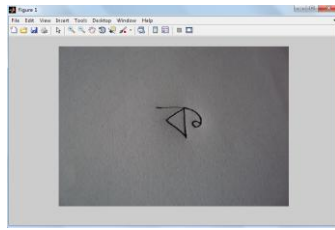


Fig.3 Input image

*A.3. Output of Gray to Binary conversion*

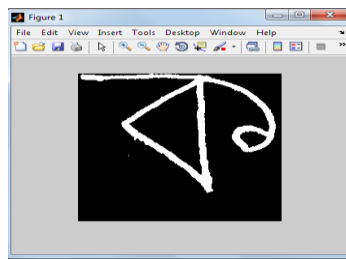


Fig. 4 Gray to Binary conversion

*A.4. Output of Feature Extraction Part*

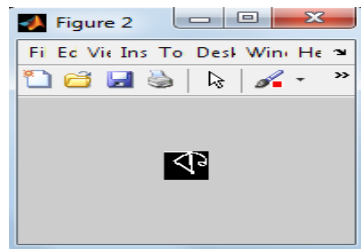


Fig. 5 Output of Feature Extraction part

*B. Input-Output Analysis*

TABLE II  
INPUT-OUTPUT ANALYSIS

Input Characters	Recognized Characters
অ	অ
আ	আ
ই	ই
ঈ	ঈ
উ	উ
ঊ	Not Recognized
ঋ	ঋ
এ	এ

ঐ	ঐ
ঔ	ঔ
ঋ	ঋ
ক	ক
খ	Not Recognized
গ	গ
ঘ	ঘ
ঙ	ঙ
চ	চ
ছ	Not Recognized
জ	জ
ঝ	ঝ
ঞ	ঞ
ট	ট
ঠ	ঠ
ড	Not Recognized
ঢ	ঢ
ণ	Not Recognized
ত	ত
থ	থ
দ	দ
ধ	ধ
ন	ন
প	প
ফ	ফ
ব	ব
ভ	Not Recognized
ম	ম
য	Not Recognized
র	র
ল	ল
শ	Not Recognized
ষ	ষ
স	স
হ	হ
ড়	ড়
ঢ়	Not Recognized
য়	য়
ৎ	ৎ
Input Character	Recognized Character
ং	ঃ
ঃ	Not Recognized
ঁ	ঁ

C. Recognized Rate

Recognized rate:  $(42/50) \times 100\% = 84\%$

## V. CONCLUSION

In this paper we show faster method for recognizing bangle handwritten character using neural network. The recognition rate of our method is remarkable. The software is implemented by using MATLAB. The input images are taken by a camera and it must be in .jpg format. After, extract feature of binary image it apply into input layer of fed-forward neural network and take output from the output layer.

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