

# Development of an Alphabetic Character Recognition System Using Matlab for Bangladesh

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DOI: 10.29322/IJSRP.9.01.2019.p8530

<http://dx.doi.org/10.29322/IJSRP.9.01.2019.p8530>

**Abstract-** Character recognition technique, associates a symbolic identity with the image of the character, is an important area in pattern recognition and image processing. The principal idea here is to convert raw images (scanned from document, typed, pictured etcetera) into editable text like html, doc, txt or other formats. There is a very limited number of Bangla Character recognition system, if available they can't recognize the whole alphabet set. Motivated by this, this paper demonstrates a MATLAB based Character Recognition system from printed Bangla writings. It can also compare the characters of one image file to another one. Processing steps here involved binarization, noise removal and segmentation in various levels, features extraction and recognition.

**Index Terms-** OCR, Character Recognition, MATLAB, Cross-Correlation, Image Processing.

## I. INTRODUCTION

Character Recognition began as a field of research in pattern identification, artificial neural networks and machine learning. The different areas covered under this general term are either on-line or off-line CR, each having its dedicated hardware and recognition methods. In on-line character recognition applications, the computer recognizes the symbols as they are drawn. The typical hardware for data acquisition is the digitizing tablet, which can be electromagnetic, electrostatic, pressure sensitive etcetera; a light pen can also be used. As the character is drawn, the successive positions of the pen are memorized (the usual sampling frequencies lie between 100Hz and 200Hz) and are used by the recognition algorithm [1]. Off-line character recognition is completed afterward the inscription or printing is performed. Examples of it are usually distinguished: magnetic and optical character recognition. In magnetic character recognition (MCR), the fonts are written with magnetic disk and are designed to modify in a unique way a magnetic field created by the acquisition device. MCR is mostly used in banking applications, for instance reading bank checks, because overwriting or overprinting these characters does not affect the accuracy of the recognition. While in optical character recognition, which is the field investigated in this paper, deals with recognition of characters acquired by optical means, typically by a scanner or a camera. The symbols can be separated

from each other or belong to structures like words, paragraphs, figures, etc. They can be printed or handwritten, of any size, shape, or orientation [2, 3]. Bangla, the mother tongue of Bangladeshis, is one of the most popular languages in the world, For the Indian subcontinent Bangla is the Second most popular language. Moreover 200 million people of eastern India and Bangladesh use this language and also the institutional language in our country [1]. So recognition of Bangla alphabet is always a special interest to us considering the massive number of official papers are being scanned and processed every day. This work aims to develop a system that categorizes a given input (Bangla Characters) as belonging to a certain class rather than to identify them uniquely, as every input pattern. It also performs character recognition by quantification of the character into a mathematical vector entity using the geometrical properties of the character image. Global usage of this system may reduce the hard labor of the concerning government employees every day.

## II. BACKGROUND

Basic Bangla character set comprises 11 vowels, 39 consonant and 10 numerals. There are also compound characters being combination of consonant with consonant as well as consonant with vowel [1, 4]. The complete set of characters, need to recognize by the proposed recognition system, is provided in Figure1.

Numerals	০ ১ ২ ৩ ৪ ৫ ৬ ৭ ৮ ৯
Independent Vowels	অ আ ই ঐ ঊ ঋ এ ঐ ও ঔ
Consonants	ক খ গ ঘ ঙ চ ছ জ ঝ ঞ ট ঠ ড ঢ ণ ত থ দ ধ ন প ফ ব ভ ম য র ল শ ষ স হ ঙ ঙ ঙ ঙ ঙ ঙ ঙ ঙ ঙ ঙ

Figure1: The whole character set of Bangla Alphabet

### A. OVERVIEW OF THE IMAGE TYPES AND PROPERTIES

The RGB (true-color) images are put in storage as 3 distinct image matrices; one of red (R) in each pixel, one of green (G) and one of blue (B); similar to the wavelength-sensitive cone cells of human eye. While in a grayscale or graylevel digital image, the value of each pixel is a single value, carries only intensity information. A grayscale image is not the black and white Binary (2-leveled) image. Gray image is represented by black and white shades or combination of levels. 8 bit gray image

represents total  $2^8$  levels, from black to white, 0 equals black and 255 is White. While Binary images, have only two probable values for individual pixel, are produced by thresholding a grayscale or color image to separate an object in the image from its background [5].

Also, color images are generally described by using the following three terms: Hue, Saturation and Lightness. **Hue** is another word for color and dependent on the wavelength of light

### III. METHODOLOGY

The proposed Bangla Character Recognition system is developed here by the following steps:

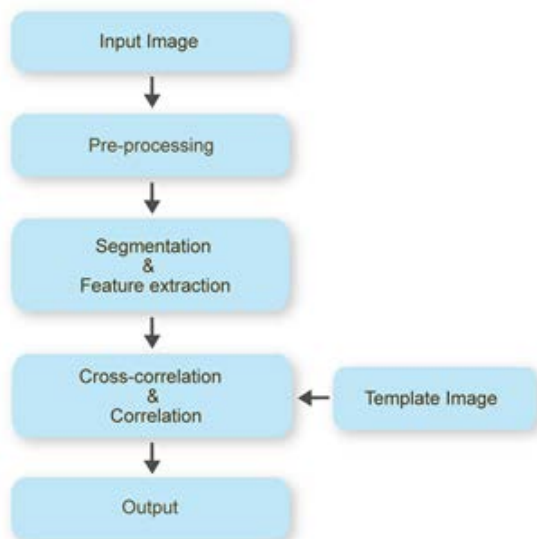
- Step1: Printed Bangla Script input to Scanner
- Step2: Raw scanned Document from Scanner
- Step3: Convert the scanned RGB image into Grayscale image
- Step3: Convert Grayscale image to Binary image.
- Step4: Segmentation and Feature Extraction.
- Step5: Classification and Post-processing.
- Step6: Output editable text.

A scanned RGB color image here is input to the system. The proposed text detection, recognition and translation algorithm (shown in Figure2) consists of following steps: *Binarization, Noise removal, Segmentation, Features extraction, Correlation and Cross-Correlation* [1, 7].

#### A. Pre-Processing

##### Binarization

Binarization is the technique here by which the gray scale pictures are transformed to binary images to facilitate noise removal. 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 in the image is the foreground color while the rest of the image is the background color. Binarization separates the foreground (text) from the background information [1-2].



being reflected or produced. **Saturation** refers to that how pure or intense a given hue is. 100% saturation means there's no addition of gray to the hue - the color is completely pure [15]. **Lightness** measures the relative degree of black or white that's been mixed with a given hue. Adding white makes the color lighter (creates tints) and adding black makes it darker (creates shades). The effect of lightness is relative to other values in the composition [6, 15].

Figure 2: An overview of the proposed Bangla character recognition system.

##### Noise Removal

Scanned documents often contain noise that arises due to the accessories of printer or scanner, print quality, age of the document, etc. Therefore, it is necessary to filter this noise before processing the image. This low-pass filter should avoid as much of the distortion as possible while holding the entire signal [1, 8].

#### B. Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics or property such as color, concentration, or quality. The result of image segmentation is a set of sections that collectively cover the whole image, or a set of lines take out from the image (or edge detection). Segmentation of binary image is achieved in altered levels contains line segmentation, word segmentation, character segmentation. Thresholding often delivers an easy and suitable method to accomplish this segmentation on the base of the different concentrations or colors in the foreground and background areas. In a single pass, each pixel in the image is related with this threshold value. If the pixel's intensity is higher than the threshold, the pixel is set to white in the output, corresponding foreground. If it is less than the threshold, it is set to black, indicating background [1, 2, 8].

##### Features Extraction

Feature taking out is the special form of dimensional decrease that proficiently characterizes exciting parts of an image as a solid feature route. This method is suitable when image sizes are huge and a condensed feature illustration is essential to swiftly complete tasks, such as image matching and recovery. Feature detection, feature mining, and matching are often combined to solve common computer vision problems such as object detection and recognition, content-based image retrieval, face detection and recognition, and texture classification [1, 9].

**C. Correlation and Cross-Correlation**

Image correlation and tracking is an optical technique that works tracking and image registration method for accurate 2D and 3D dimension of changes in images. *Cross-correlation* is the measure of similarity of two images. Each of the images is divided into rectangular blocks. Each block in the first image is correlated with its corresponding block in the second image to produce the cross-correlation value as a function of position [10,11].

**IV. MATLAB IMPLEMENTATION**

An implementation is the realization of a technical specification or algorithm as a program, software component, or other computer system through computer programming and deployment. The proposed system is implemented in MATLAB and the accuracy is also tested. Using MATLAB 'imread' function of, a noisy scanned RGB image is loaded to the input system (Figure.3). After performing Grayscale conversion by 'rgb2gray', Figure.4 is thus obtained; 'rgb2gray' eliminates the hue and saturation information of the RGB image while retaining the luminance. Figure.5-6 shows outcome after binarization (using 'im2bw') and noise-removal from this black and white image. Figure.7-8 shows the process of character segmentation [12-13].

Performing cross-correlation between input image and template image, the peak point is found (Figure.9). Peak point is the point that indicates the highest matching area based on cross-correlation. Thus, the appropriate character is identified (Figure.10). Here Bangla Unicode Characters' hex value is used to make the recognized character machine-readable. Recognized character is here displayed in MATLAB built in browser [14].

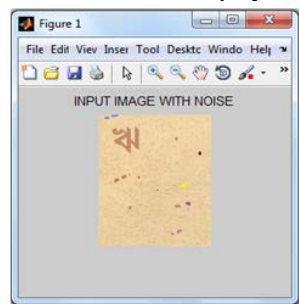


Figure 3: Input Image (RGB) with noise

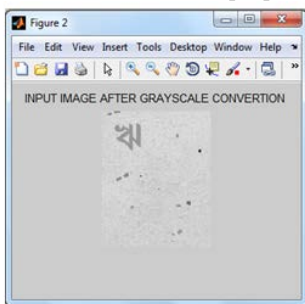


Figure 4: Converted Gray scale Image

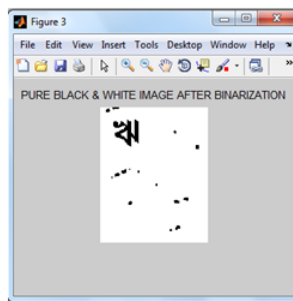


Figure 5: Processed Image after Binarization.

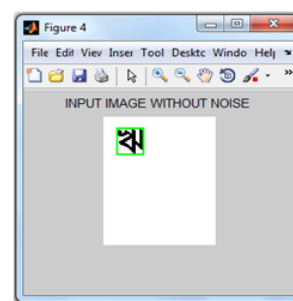


Figure 6: Processed Image after removing noise.

Figure 7: Image information for segmentation  
0 represented by Black & 1 represents White.

Figure 8: Character after Segmentation.

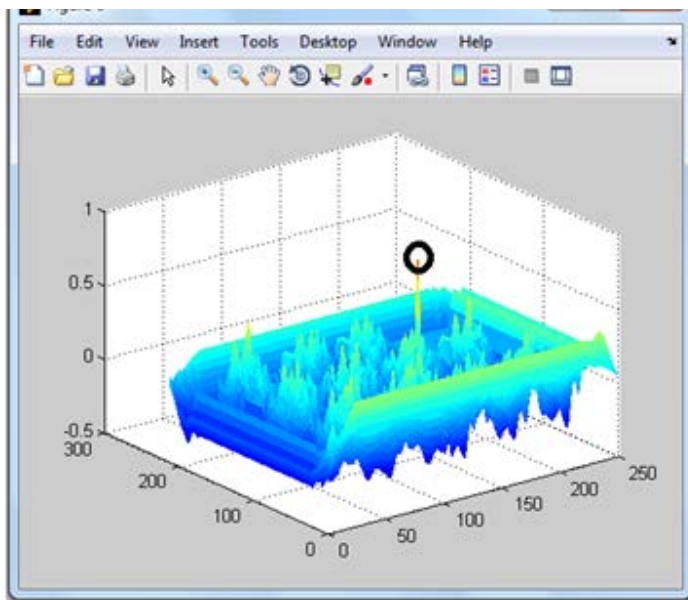


Figure 9: Marked Peak in cross correlation refer Character Detection

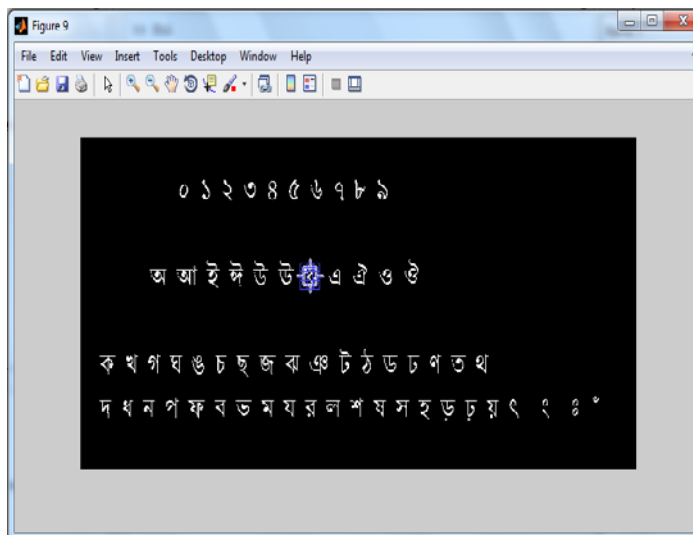


Figure 10: Recognized character from Template.

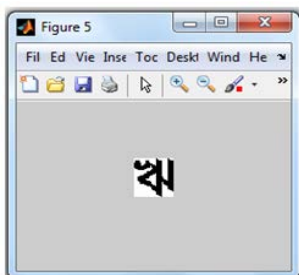




Figure 11: Computer editable Character

## V. GUI (GRAPHICAL USER INTERFACE) DEVELOPMENT

A user-friendly Graphical User Interface is also designed for this system, where user can insert an image to recognize the desired character. User can input any image using “Load Image” option. After loading an image, user can select a character using mouse pointer, crop image and continue processing using “Image Processing” option. Following the algorithms, the system would recognize the selected character and provide it in editable format if “Recognize Character” command is executed from the options.

## VI. ANALYSIS

The recognition rate of the proposed recognition method is remarkable with the accuracy rate of almost 98-100%. Image processing toolbox and built in MATLAB functions have been quite helpful here for detection of single Bangla character and digit. The input images can be taken from any optical scanner or camera. The output allows saving recognized character as html, txt etcetera format for further processing. The only limitation of the system is the fixed font size of the character. Further improvement for all possible font type and size is reserved for the future. Also it is developed only for single Bangla character recognition at a time. Multiple characters recognition along with connected letters is also left open for the future. Connecting the program algorithm with the neural network may also be helpful.

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## VII. CONCLUSION

Complex character based language like Bangla clearly demands deep research to meet its goals. Recognition of Bangla characters is still in the intermediate stage. The proposed system is developed here using template matching approach to recognize individual character image. Even though the user-friendly GUI gives several advantages to individual users, this system is still facing a number of limitations which is quite considerable. Improving the system to suit handwritten characters, all printed fonts in considerable amount of time with high accuracy is the recommended future work.

## ACKNOWLEDGMENT

At first all thanks goes to almighty creator who gives me the opportunity, patients and energy to complete this study. I would like to give thanks to Mr. Masudul Haider Imtiaz; Assistant Professor at Institute of Science and Technology. I have found always immense support from him to keep my work on the right way. His door was always open for me, when I have got myself in trouble.

Finally, I must express my very profound gratefulness to my



Figure 12: A specific instance of character recognition using developed MATLAB GUI

parents and to my wife for providing me with constant support and encouragement during my years of study and through the process of researching and writing this paper. This accomplishment would not have been possible without them. Thank you.

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