Handwritten Numeral Recognition by Template Matching using Scilab

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Abstract— Handwritten character recognition is comparatively difficult, as different people have different handwriting styles. The aim of the present work is to recognize the numerals written by various persons and convert the recognized numerals into words. Template matching process is used to recognize the characters using normalised correlation method. Numerals 0-9 written by different persons with different style of handwriting are presented to the system. The presented character is used as image template which is compared with the search image. The proposed systems spot the detected character in the search image, show it into typed form and convert it into words. The accuracy of proposed system is 98.33 % and which can be further increased as system has flexibility to include more handwriting styles. The proposed system can be easily utilized in the application like OMR sheets where there is need to write the numerals values in figures as well as words. Scilab an open source software is used for recognition of these handwritten numerals.

Key words: Character Recognition, Template Matching, Normalized Correlation

I. INTRODUCTION

Template matching method in image processing is used when standard deviation of the template image compared to the source image is very small. Templates are most often used to identify printed characters, numbers, particular patterns and other small, simple objects. template image is moved to all possible positions in a larger source/search image and computes a numerical index indicating the match of template image in that position. This match is done pixel-by-pixel.

A lot of work has been done where Template matching is used in Optical Character Recognition system. This technique is useful to recognize the character or alphabet by comparing two images of the alphabet. The objectives of these type of system is to develop a prototype for the Optical Character Recognition (OCR) system and to implement the Template Matching algorithm in developing the system prototype.[1]

Another application of Image processing is in Document Image Recognition (DIR) which is a very useful practice in office automation and digital library applications; the objective is to find the most similar template for any input document image in a prestored template document image data set. It is concluded by authors that a very high matching accuracy can be obtained even for a large template set and seriously distorted input images. [2]

As template matching algorithm has the characteristics of high speed and real-time, a method of weighted matching degree is also used which can provide a higher matching rate of image character, and also overcoming the wrong recognition produced by traditional calculation method. It also guarantees the accurate recognition rate of general character and avoids the influence of adherent noise and partial distortion, which has a great impact on the recognition rate of the character [3]. Pattern spotting in historical document images to search the occurrences of a given visual pattern in document imaging is also one of the major applications of template matching in image processing. In these systems a query image is given, the pattern spotting system first computes the similarity score between the query signature and the signatures of a few regions provided by a region proposal algorithm. The top ranked regions are then selected by pattern spotting system which are further processed to maximize the matching score.[5]

Optical character recognition (OCR) is very popular for its application in medical field also, where it is used to detect various complex diseases. Scoliosis a disorder of the spine is detected by researchers in which the spinal detection method template matching based on Sum of Squared Difference (SSD) can be used. This method is used to estimate the location of the vertebra. By using polynomial curve fitting, a spinal curvature estimation can be done. The performance of SSD method used to detect a variety of data sources of X-Ray from numerous patients was discussed. The algorithm proposed by author can be used to detect all the X-ray images [7]. License plate detection and recognition system based on OCR system has a lot of applications. Different countries recommend different color and font sizes for license plates. Complex background of Bangladeshi license plates make it more difficult to use the existing algorithms.

As there commercial License Plates have the unique color green of its own. So the portions of green color with the matching RGB intensity of the plate were selected. Different algorithms have been proposed to track down the license plate in the vehicle region. In the end, template matching has been used for recognizing the characters and the digits of the Bangla license plate. [8]

The most of the optical character recognition system are developed using Matlab, Java IDE and mysql as a database[9]. But here in the present work open source software Scilab is used to detect the handwritten characters as Scilab is most proficient alternative for pattern recognition application as compare to MatLab and other licensed and expensive software [10].

II. PRESENT WORK

In the present work template matching technique with normalized cross correlation [11] is used to recognize the handwritten characters.

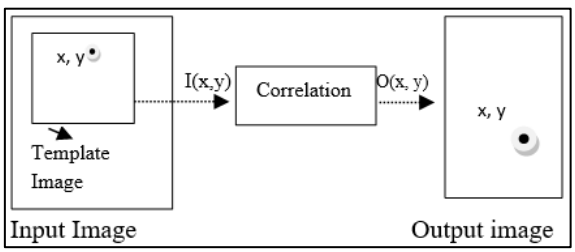

Fig. 1: Correlation of two images

Basically Correlation is a measure of the degree to which two variables agree in their general behavior. Here these two variables are the corresponding pixel values in two images i.e. template image and source image.

Correlation C_{fg} of two images f and g is

$$C\,fg = \sum_{[i,j[i,j]\in R]} f(i,j)g(i,j)$$

Intensity normalization of Image f and g

$$\hat{f} = \frac{f - \bar{f}}{\sqrt{\sum(f - \bar{f})}}, \qquad \hat{g} = \frac{g - \bar{g}}{\sqrt{\sum(g - \bar{g})}}$$

Normalized cross correlation NCC is

$$NCC(f,g) = Cfg\left(\hat{f},\hat{g}\right) = \sum_{[i,j]\in R} \hat{f}(i,j)\hat{g}(i,j)$$

Fig 2 shows the block diagram of the proposed work. Firstly, a scanned source image with different handwriting styles of different persons is selected and picked by the system. This is source image and is in .bmp format. Next step is to get the template image. It is the image which is required to be detected. Both of these images i.e template image and source image are converted into gray scale. The main purpose of Gray scale conversion is to remove the noise from image, hence increasing the accuracy of the system. Normalized cross correlation method of template matching is used to match and find the template image in source image.

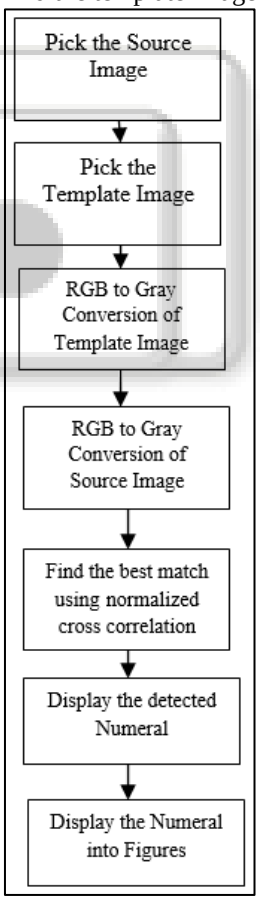

Fig. 2: Block diagram of proposed system

After execution of the algorithm the detected character is marked in the source image. A further processing is also done in which this detected character is converted into words. This output also appears in the console window of the Scilab.

III. Result and Discussion

In this research handwritten numbers 0-9 written by three different persons with varying handwriting styles as shown in Figure 3 are tested. One character written by one person is presented to the system as a template image (Figure 4).

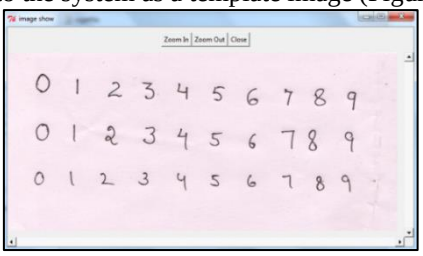

Fig. 3: Source Image

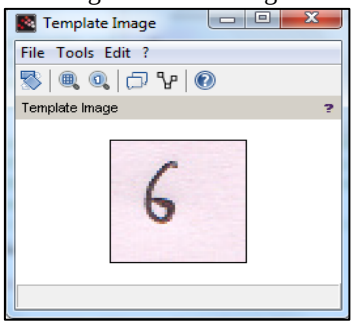

Fig. 4: Template image

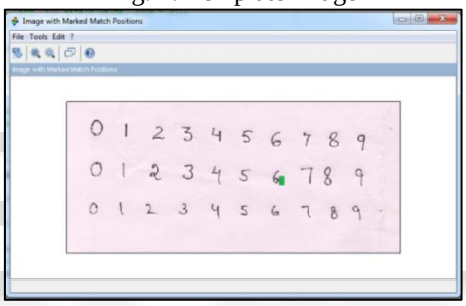

Fig. 5: Image with marked matched position (Green color mark)

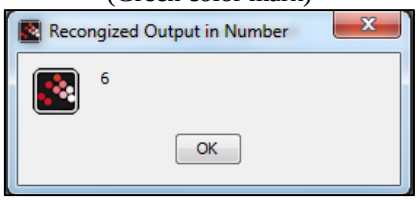

Fig. 6: Recognized output converted in numbers

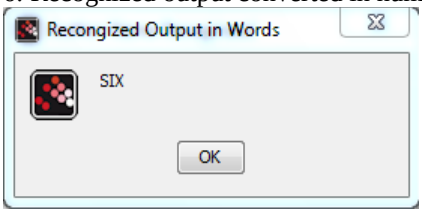

Fig. 7: Recognized output converted into words

IV. Conclusion

Experimental results indicate that present system can be easily applied to the application where one needs to detect the numeral value and convert it into figures e.g. in OMR sheets. The results in editable form also appear on the console window of Scilab. The system demonstrates high accuracy of 98.33% for various size and style of handwriting.

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