Optical Character Recognition By Using Template Matching (Alphabet)

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ABSTRACT

Optical Character Recognition by using Template Matching is a system prototype that useful to recognize the character or alphabet by comparing two images of the alphabet. The objectives of this system prototype are to develop a prototype for the Optical Character Recognition (OCR) system and to implement the Template Matching algorithm in developing the system prototype. This system prototype has its own scopes which are using Template Matching as the algorithm that applied to recognize the characters, characters to be tested are alphabet (A – Z),grey-scale images were used with Times New Roman font type, using bitmap image format with 240 x 240 image size and recognizing the alphabet by comparing between two images. The purpose of this system prototype is to solve the problem in recognizing the character which is before that it is difficult to recognize the character without using any techniques and Template Matching is as one of the solution to overcome the problem. *Matlab R2006a* is the software tool that was used in developing the system prototype. There are a few processes that were involved in this system prototype. The processes are starting from the acquisition process, filtering process, threshold the image, clustering the image of alphabet and lastly recognize the alphabet. All of these processes are very important to get the result of recognition after comparing the two character images.

INTRODUCTION

Optical Character Recognition is the process whereby typed or printed pages can be scanned into computer systems, and their contents recognized and converted into machine-readable code [1]. Template matching is one of the Optical Character Recognition techniques. Template matching is the process of finding the location of a sub image called a template inside an image. Once a number of corresponding templates is found their centers are used as corresponding points to determine the registration parameters. Template matching involves determining similarities between a given template and windows of the same size in an image and identifying the window that produces the highest similarity measure. It works by comparing derived image features of the image and the template for each possible displacement of the template. The Optical Character Recognition (OCR) applications are very important in many fields. Some of the fields which the OCR applications were used are such as in business, banking, government, travel industry and hotel industry. In the business, the OCR applications are used for data entry automation for ordering entry and file folder tracking of names and numbers. Besides, in government, the OCR applications were used for utility billing such as tax, water, fee, voting cards and license bills. Airline tickets and passports are also the OCR applications in Travel Industry field [2].

PROBLEM STATEMENT

The earliest OCR that was invented by Jacob Rabinow since late 1940's was primitive mechanical devices with fairly high failure rates. Since the amount of new optical material increased, so it is need a drastic alternative to overcome the problem, but somehow these machines (OCR) were clearly not up to the task. So to overcome this problem, Template Matching is one of the solutions that were suitable to implement in recognizing the optical character because of the simple algorithm that was used.

OBJECTIVE

i) To develop a prototype of Optical Character Recognition (OCR) system.
ii) To apply a Template Matching approach in recognizing character.

SCOPE

i) Template Matching is the algorithm that applied to recognize the characters.
ii) Characters to be tested are alphabet (A – Z).
iii) Grey-scale images were used with Times New Roman font type.
iv) Using bitmap image format
v) Using 240 x 240 image size
vi) To compare between two images of alphabet

WORKFLOW OF THE TEMPLATE MATCHING ALGORITM

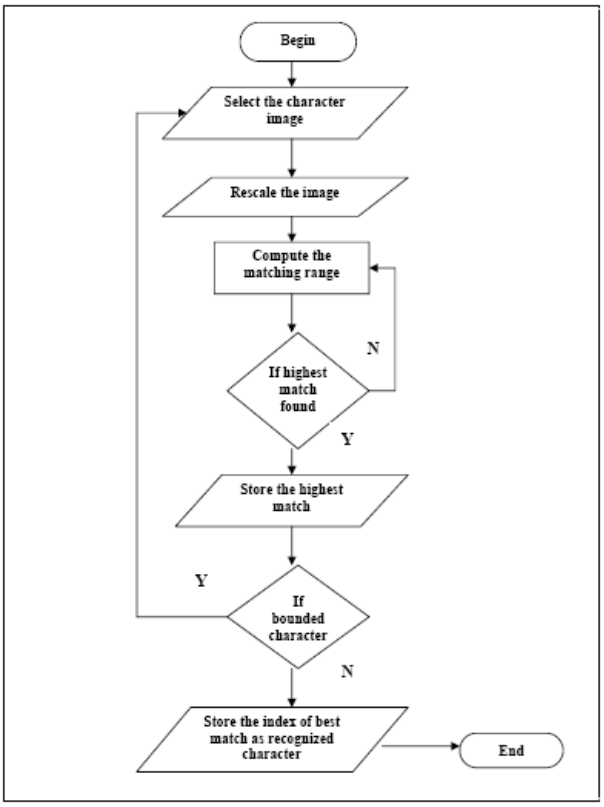


Figure: Workflow of the Template Matching Algorithm

TEMPLATE MATCHING STEPS FOR RECOGNITION

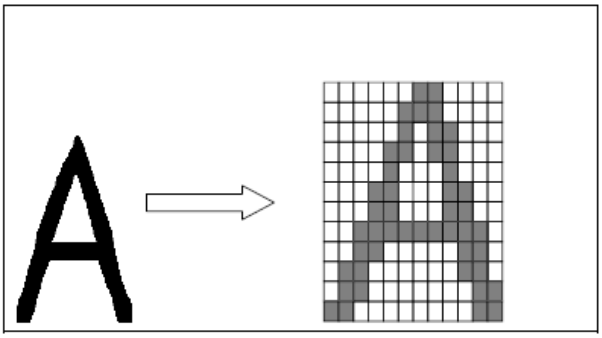
The template-matching algorithm implements the following steps:

i) Firstly, the character image from the detected string is selected.
ii) After that, the image to the size of the first template is rescaled.
iii) After rescale the image to the size of the first template (original) image, the matching metric is computed.
iv) Then the highest match found is stored. If the image is not match repeat again the third step.
v) The index of the best match is stored as the recognized character.

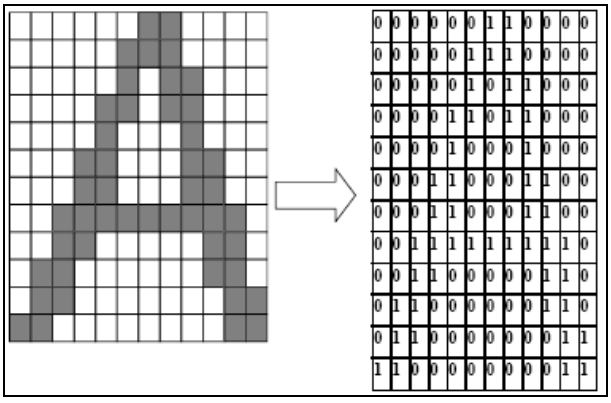
The value of the data that was entered will be extracted from the images, comprising letters. Each character was automatically

selected and threshold using methods previously described.

Extraction of the image of the character. The image is converted into 12x12 bitmap.



Bitmap is represented by 12x12-matrix or by 144 vectors with 0 and 1 coordinates.



TEMPLATE MATCHING ALGORITHM

This process involves the use of a database of characters or templates. There exists a template for all possible input characters. For recognition to occur, the current input character is compared to each template to find either an exact match, or the template with the closest representation of the input character. If *I(x, y)* is the input character, *тn(x, y)* is the template n, then the matching function *s(I, тn)* will return a value indicating how well template *n* matches the input character .Some of the more common matching functions are based on the following formulas:

$$s(I,Tn)=\sum_{i=0}^{w}\sum_{j=0}^{h}|\,I(i,j)-Tn(i,j)\,| \quad (1)$$

$$s(I,Tn)=\sum_{i=0}^{w}\sum_{j=0}^{h}(I(i,j)-Tn(i,j))^{2} \quad (2)$$

$$s(I,Tn)=\sum_{i=0}^{w}\sum_{j=0}^{h}I(i,j)Tn(i,j) \quad (3)$$

$$s(I,Tn)=\frac{\sum_{i=0}^{w}\sum_{j=0}^{h}(I(i,j)-|I|)(Tn(i,j)-|Tn|)}{\sqrt{\sum_{i=0}^{w}\sum_{j=0}^{h}(I(i,j)-|I|)^{2}}\sqrt{\sum_{i=0}^{w}\sum_{j=0}^{h}(Tn(i,j)-|Tn|)^{2}}} \quad (4)$$

Matching Formula; 1) City block, 2) Euclidean, 3) Cross Correlation,4) Normalized Correlation

Character recognition is achieved by identifying which *Tn* gives the best value of matching function, *s*(*I* ,*Tn*) . The method can only be successful if the input character can the stored templates are of the same or similar font. Template matching can be performed on binary, threshold characters or on gray-level characters. For gray-level characters, it is more common for Normalized Correlation to be used as this provides improved resistance to variations in brightness and contrast between the input character and the stored template.

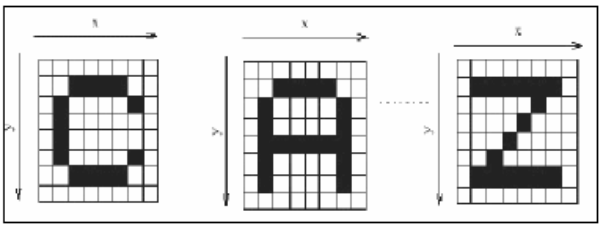


Figure: Template Matching

TEMPLATE MATCHING APPROACH

Template matching models were developed as an answer to the problem of object recognition, and they incorporate at least implicitly the idea of similarity comparison. The representations assumed by template models carry much more detailed information about stimulus structure than do the element representations just described. These models are usually applied to spatially extend visual objects, and their representation can be thought of as being spatially organized [7]. The central concept behind the template matching algorithm is reference points. Reference points are points at the center of spatial regions in 3-D space. For this particular system, the regions were defined as an x, y, z center point, and three distance values, one for each axis. By alternately adding and subtracting the distance values along the appropriate axis about the center point, a region in the shape of a cube is formed. A possible alternative would be to define a point and a radius, and subsequently describe a sphere as the region. The origin for the coordinate system is defined to be the center of the subject's right shoulder socket. Since the data from the wrist tracking sensors is normalized to this origin, it is relatively easy to determine which reference point region the sensor is in at a given moment. Reference point regions are defined to correspond to the locations of the sensors when gestures are executed. Also, by negating the right/left axis value for the center point, a symmetric set of regions is defined for the left hand sensor.

FILTERING IMAGE

Filtering is one of the processes in image processing before further steps are taken. Filtering is a process by which unwanted substances are removed from a mixture of elements, thus leaving useful material behind. Filtering also a technique for modifying or enhancing the image. There are many types of filtering the image. Some of the filtering types are such as the minimum filtering, maximum filtering, median filtering, average filtering and others. All of them have their own algorithm. Some of the algorithm that was applied in the technique is such as below:

Average filtering technique algorithm

$$S = \frac{1}{N^2} \sum_{(r,c) \in W} d(r, c) \quad (5)$$

Overall, the filtering technique that used by using average filtering algorithm is counting the average values of the image from each window to another window. The windows are called N x N .This calculation is using the changes concept of the windows to process the image. So that, the filtering of the image is using the algorithm as above to filter the image.N_2 means the total of pixels in each window which called as W. The maximum and minimum filters are two order filters that can be used in filtering the image. The maximum filter selects the largest value within an ordered window of pixel values, whereas the minimum filter selects the smallest value.

THRESHOLD IMAGE

The second process after filtering the image is the threshold technique. There a lot of techniques for threshold the image such as the minimum threshold, maximum threshold, median threshold and the average threshold.

Threshold technique is the technique that used to transform a grayscale image into a binary image which is using (1 or 0) values. A threshold is set which each pixel is compared to other pixels. If the pixel is greater than or equal to this threshold, it is outputted as a 1.Otherwise it is outputted as a 0.Threshold converts each pixel into black, white or unchanged depending on whether the original color value is within the threshold range.

$$\text{A pixel becomes } \begin{cases} \text{white if its gray level is } < T & (6) \\ \text{black if its gray level is } >= T & (7) \end{cases}$$

The algorithm that shown as below is the algorithm that was used to threshold the

image. This algorithm is called average threshold technique. The average threshold technique is based on the average value of the image. Every point is the pixels value of the image. The value of each point is added and it divided by the number of points that is counted for each image. This is important to get the threshold value of the image which is 0 and 1.

$$S = \frac{1}{N^2} \sum_{(r,c) \in W} d(r,c) \quad (8)$$

Other techniques for threshold the image are Maximum threshold, Minimum threshold and Median threshold. All of them also have their own algorithm. Maximum threshold technique is based on the maximum value of the image, while the minimum threshold technique is based on the minimum value among all of the pixels in the image.

Maximum and Minimum threshold technique algorithm:

$$y_i = \begin{cases} x_i & \text{if } x \geq y_{i-1} \quad (9) \\ y_{i-1} & \text{if } x_i < y_{i-1} \text{ and} \quad (10) \\ x_{i-n} = y_{i-1} & \quad (11) \end{cases}$$

Median technique is the threshold technique that counts the median value of the pixel in the image.

$$x_1 < x_2 < \dots < x_n \quad (12)$$

x in the algorithm above is refers to the value of the image and it will be count until getting the median value among all the pixels in the image.

RESULT

For the result of this system, it has a main page which is the interface of the system. Actually, while using the Matlab software, the interface of the system is just has one interface and all the processes of the system was done in the same interface but different functionality. For this system, the recognition process is done using step by step and the user has to click the buttons which are providing in the system. The character recognition process is started with entering the image that the user wants to test and it displayed at the box that was provided in the system.

CONCLUSION

As an overall view of the system prototype, it could be conclude that this system prototype has been developed by using the technique that has mentioned and elaborated which is the Template Matching approach to recognize the character image. Besides, the interface of the system prototype looks user-friendly and makes the user of this system prototype easier to use it. As a result, the recognition process of this system become smoothly because of the steps that used in this system while recognizing the character. Even though this system prototype could gives several advantages to the users, but this system prototype are still facing a number of limitations. So that, further research could be done by other person to improve the system prototype into a better system.

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