Image_Edge_Detection_Operators_for_Lontara_Sanskrit_Scripts.pdf

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Submission date: 26-Apr-2020 08:36PM (UTC+0700)
Submission ID: 1308057734
File name: Image_Edge_Detection_Operators_for_Lontara_Sanskrit_Scripts.pdf (516.58K)
Word count: 2160
Character count: 11386

Performance Comparison of Image Edge Detection Operators for Lontara Sanskrit Scripts

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***Abstract*—Processing of image digital is a technology that can be used to enhance images and information about objects in images. Edge detection in digital image enhancement is a process that produces parts of image objects for segmentation and creativity of objects in the image. This research aims to get the best operators to detect the character of the word *Lontara* in Sanskrit manuscripts. This research also uses morphological operations in binary images to identify the many forms of the character of the word *Lontara*. Edge detection operators used are Sobel, Canny, Prewitt, and Roberts. There are 2 types of images used in this study are good quality images and poor-quality images. The parameter used to measure operator performance is Mean Square Error (MSE). The results we obtained from Roberts operator are the best operators to detect the location of the script with an MSE value of 0.8370 in images of good quality, MSE value of 0.8688 in images of poor quality.**

Keywords—edge detection, sobel operator, prewitt operator, roberts operator, canny operator, morphology

I. INTRODUCTION

The image can be said as a digital image if the image is stored in digital format (in the form of a file). An image is a representation, resemblance, or imitation of an object. The process of digitizing on data images is also the process of converting an analog image of data form into digital data, which can be done with tools such as a camera or scan. The digitization process sometimes makes the experience distortion, contain noise or other things that can be interpreted without reducing information on the image. Image processing has a variety of operations such as image segmentation, image analysis and image reconstruction. Edge detection is one of the most basic tasks in digital image processing and pattern recognition. The edge extraction and detection plays an important role in image processing [1]. Edge detection process outlines of an object and boundaries between objects and the background in the image [2,3]. Selection of threshold value also affects the results of edge detection, if the selection of the threshold value is too low then the resulting edge will be very thin or even missing, if the threshold selection is too high it will make more noise in the image, the resulting edge will be very thick and make the edge structure look unclear. *Lontara* Sanskrit word has many characters and in different shapes and sizes, we use morphological processes on edge detection.

In this research, the edge detection image analysis operation will be carried out on the image of the *Lontara* Sanskrit script that will compare the results of edge detection in order to find out the best operators by using Sobel, Prewitt, Canny and Roberts operators in and we will use 3 threshold values in the *binarization* process, where the threshold value will be adjusted based on the image needs used, and use the process of erosion, dilation, opening and closing morphology. The parameters used to measure the comparison value are the MSE value on the results image.

II. METHODOLOGY

A. Research Flowchart

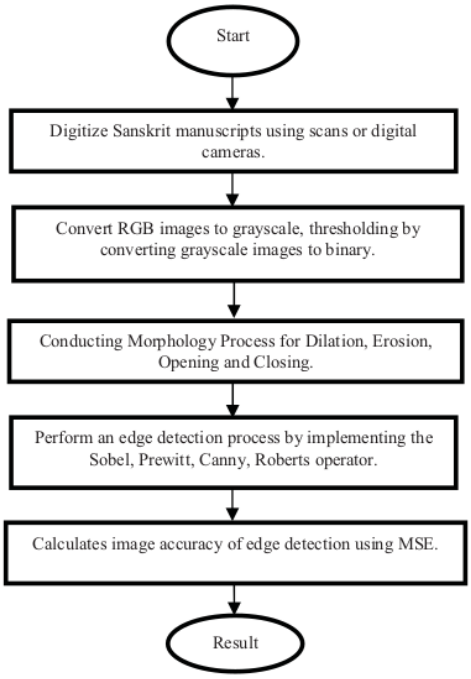

Fig. 1. Research Flowchart

B. Research Methodology

Fig. 1, this research includes experimental research where researchers do direct recording of the results of edge detection image processing both visually and in MSE calculations [4-6].

1) The Data used: there are 2 types of Sanskrit manuscript in this case is the *Lontara* script, where 1 image has good original image quality and 1 image has poor original image quality with JPG image extension.

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2) Data Analysis Techniques

- Change the RGB image format to Grayscale. Then thresholding the grayscale image.
- Perform the process of morphology of Dilation, Erosion, Opening and Closing in binary images.
- Carry out an edge detection process by applying the Sobel, Canny, Prewitt and Roberts methods to each image that has been carried out by morphological processes.
- Evaluate the MSE value on the image that has been detected by the edge to measure the accuracy of each operator.

C. Sobel Operator

Sobel Operator is the development of the Robert method using an HPF (High Pass Filter) filter which is given a zero-buffer number [7],[8]. Sobel operator is the magnitude of the gradient is calculated as below.

$$G[f(x,y)] = \sqrt{G_x{}^2 + G_y{}^2} \quad (1)$$

The partial derivative is calculated by

$$G_x = (a_2 + ca_3 + a_4) - (a_0 + ca_7 + a_6) \quad (2)$$

$$G_y = (a_0 + ca_1 + a_{22}) - (a_6 + ca_5 + a_4) \quad (3)$$

Review of pixel arrangement around the pixel (x, y):

$$\begin{bmatrix} a_0 & a_1 & a_2 \\ a_7 & (x.y) & a_3 \\ a_6 & a_5 & a_4 \end{bmatrix}$$

Constant c = 2. In the form of mask, G_x and G_y can be expressed as follows:

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} and\ G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

D. Prewitt Operator

Prewitt operator equation on the same gradient as Sobel operator, but using a value of c = 1

$$P_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \text{dan } Py = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

E. Roberts Operator

The Roberts operators are often called cross operators. Roberts's gradient in the x-direction and y-direction is calculated by the formula:

$$R_+(x,y) = f(x+1, y+1) - f(x,y) \quad (4)$$

$$R_-(x,y) = f(x, y+1,) - f(x+1, y) \quad (5)$$

In the convolution mask form, Roberts operator is:

$$R_+ = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} dan\ R_- = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

Edge strength is generally calculated by a formula:

$$G[f(x,y)] = |R_+ - R_-| \quad (6)$$

F. Canny Operator

There are several most optimum edge detection criteria that can be met by the Canny algorithm:

1) Detecting well (detection criteria): The ability to put and mark all existing edges in accordance with the selection of convolution parameters performed. At the same time it also provides very high flexibility in determining the level of edge thickness *detection* as desired.

2) Well localized (localization criteria): Canny allows to produce a *minimum* distance between edges detected with the original edge.

3) Clear response (response criteria): There is only one response for each edge. So that it is easy to detect and does not cause confusion in subsequent *image* processing.

To find out the best operator, MSE calculation is used. MSE is the average square error value between the cover image and a stenographic image.

$$MSE = \frac{1}{m \times n} \sum_{i=0}^{n-1} \sum_{i=0}^{m-1} [f(i,j) - g(i,j)^2 \quad (7)$$

G. Morphology Process

1) Dilation and Erosion: are basic things morphological operations. Dilation can be used to pad some empty holes in the object region and remove small particle noise is contained in the object region [3],[9],[10]. Erosion can be used to reduce the image structure.

Dilation:

$$A \oplus B = \{ z \mid z = a + b, a \in A \text{ and } b \in B \quad (8)$$

Erosion:

$$A \ominus B = \{ z | p \in Z^2 | (a+b) \in I, \forall \in B \} \quad (9)$$

2) Opening operation: an erosion operation followed by dilation using the same structural element. All foreground structures smaller than the structural elements will be eliminated by erosion and then smoothing is done through by dilation.

$$A \circ B = (A \ominus B) \oplus B \quad (10)$$

3) Closing operations: useful for removing contours and removing small holes. Closing operations are carried out by conducting dilation operations which are *then* followed by erosion operations.

$$A \bullet B = (A \oplus B) \ominus B \quad (11)$$

H. Threshold Identification

Threshold identification is required in order to distinguish between the images which have light background with dark foreground and dark background with light foreground [2].

III. RESULTS AND DISCUSSION

A. Image Conversion

In the input image of the Sanskrit manuscript where the script chosen is the *Lontara* script is an RGB image so that it will be converted into a grayscale image. The image is obtained as shown in Fig. 2 and 3

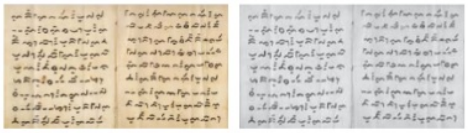

Fig. 2. RGB image in good quality image

Fig. 3. Grayscale image in poor quality image

Then thresholding is done by changing the grayscale image into binary image where at this stage using 3 threshold values adjusted to the image needs, for images with good quality given values 65, 60 and 55, while for poor quality images given a threshold value of 81, 80, 78. The binary image is obtained as shown in Fig. 4 and 5.

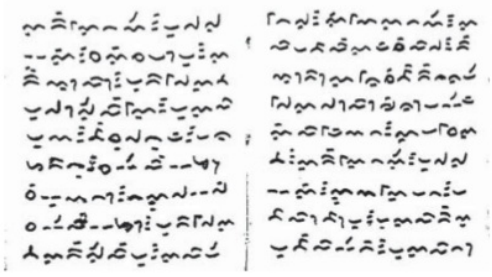

Fig. 4. Binary imagery with a threshold value of 65

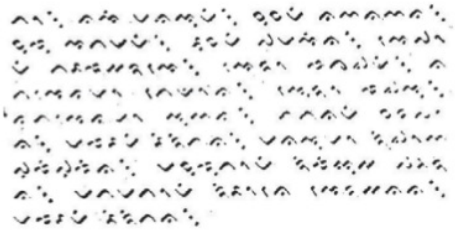

Fig. 5. Binary imagery with a threshold value of 81

B. Morphological Process

The morphological process that will be used is the process of dilation (8), erosion (9), opening (10) and closing (11) that will be applied to each image that has gone through the binary process with their respective threshold values. Morphological goals are to improve segmentation results. Fig. 6 and 7 shows examples of the results of morphological process.

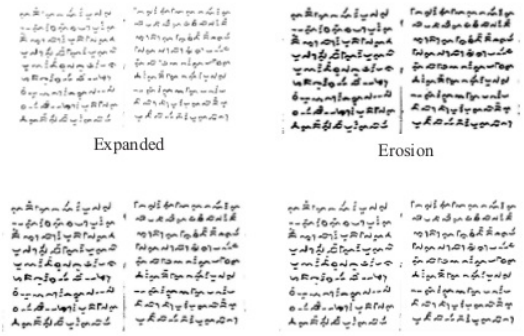

Fig. 6. Morphological results in good quality image

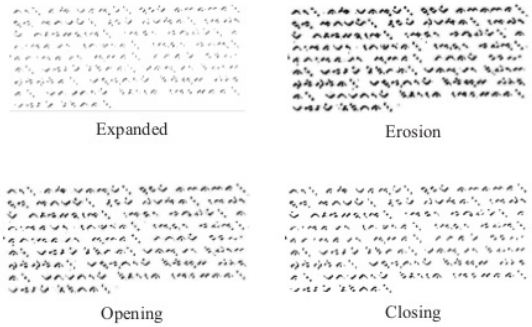

Fig. 7. Morphological results in poor quality image

C. Edge Detection

The edge detection operators used in this study are Sobel, Canny, Roberts and Prewitt which are applied to each image that has been done by dilation, erosion, opening and closing processes. There are 32 images from the results of edge detection that has been carried out, 16 images from the results of good quality images with threshold values of 65, 60, 55 and 16 images of poor-quality images with threshold values of 81, 80 and 78. Fig. 8 and 9 shows examples of the results of edge detection.

D. Calculation Results

The results obtained from the calculation of MSE (1) will be obtained calculation results are of good quality and the image with the image of poor quality in order to get the best and consistent method, calculation results with good quality image will shows in the following chart in Fig. 10.

Fig. 8. The edge detection results with dilasi morphological and 65 treshold value in good quality image

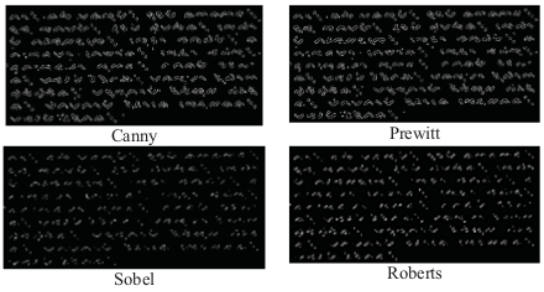

Fig. 9. The edge detection results with dilasi morphological and 81 treshold value in poor quality image

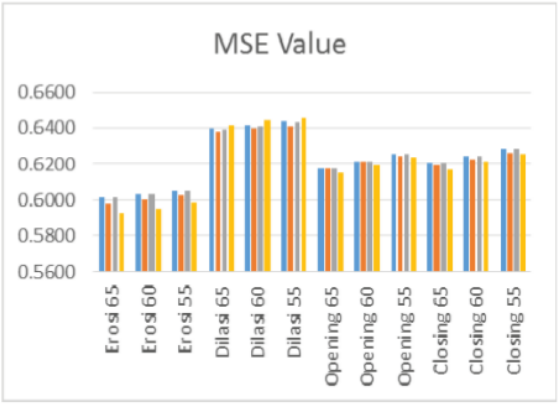

Fig. 10. MSE values of the good quality images

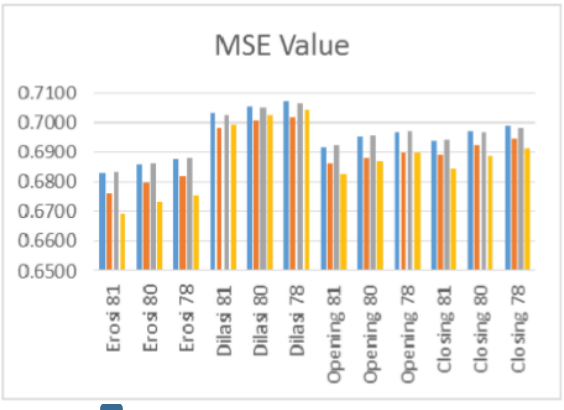

Fig. 11. MSE values of the poor quality images

From the research that has been done, the best MSE value is 0.5924 on the Roberts method with a threshold value of 65 using the erosion morphology operation.

The results of calculations with poor quality images will be shown in the following chart in Fig. 11.

From the research that has been done, the best MSE value is 0.6692 on the Roberts method with a threshold value of 81 using the erosion morphology operation.

IV. CONCLUSION

The purpose of this paper is to find the best edge detection operator based on the data used by researchers by finding the smallest error value. The paper has presented the comparison results of four major edge-detection operators which is applied into both good- and poor-quality of the images of Lontara script. The research showed that in the good quality images using Sobel, Prewitt, Canny and Roberts operators, respectively, the best method is Roberts operator with erosion morphology process with 65 threshold values, and the MSE value is 0.5924. Whereas in the poor-quality images we obtained that Roberts operator is also the best method with erosion morphology process with 81 threshold values, and the MSE value is 0.6692. Therefore, our results conclude that Roberts operator is consistent as the best operator.

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