Bisindo Alphabets Edge Detection Using Color Tracing of Object Boundary

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***Abstract*—This paper proposes a method of edge detection for BISINDO alphabets formed using hand gestures. In image processing for edge detection process, it is very important section for using image analysis process for the next step. The goal of this study was to detect BISINDO letters edge using color tracing at object boundaries. BISINDO was an abbreviation of Indonesian sign language. There were 26 images of BISINDO letters tested. They represented letters A to Z. There was 3 steps in this study; the first was segmentation process using similarity measurement model based on color similarity and using thresholding technique, the second was morphology process using mathematical morphology with closing operator, and the last step was object boundaries tracing used in outside boundary tracing of an object and whole boundary in the object. The result of this study was the object boundaries detected with blue color whereas holes were detected with red color for 26 BISINDO letters (letter A to Z). Recognition accuracy rate for this study was 100%.**

Keywords—bisindo, segmentation, morphology, object boundary tracing

I. Introduction

People with hearing and speech impairment in Indonesia communicate using 2 sign languages, Indonesian sign language known as BISINDO and Indonesian sign language system known as SIBI. BISINDO was developed by hearing loss people via an organization named GERKATIN while SIBI was developed by normal people. SIBI is same as the sign language used in America i.e., American Sign Language (ASL) [1].

Edge detection plays a very significant role to identify object boundaries in an image [2]. The edge representation of an image significantly reduces the amount of data in the image but it saves very important information on its image shape [3]. An Object feature can be obtained through contour object shape [4-5]. The study on edge detection of a wide range of objects using edge detectors has been conducted by researchers [6-8]. Edge detection for BISINDO letters using Roberts operator [4] and [9] with recognition accuracy was 100%. The aim of this study was to find out the contour edges of BISINDO alphabets that have different contour edges based on color tracing. The letters were obtained from hand gestures. The outside edge of the object was colored in blue while the inside edge of the object (holes) was colored in red. The results of this study was to find the object boundaries from the 26 images of BISINDO letters. The recognition accuracy rate was 100%.

II. Methodology

The stage of edge detection system shown in Fig. 1 consists of 4 stages; 1. BISINDO Letter image, 2. Segmentation, 3. Morphology and 4. Object Boundary Tracing.

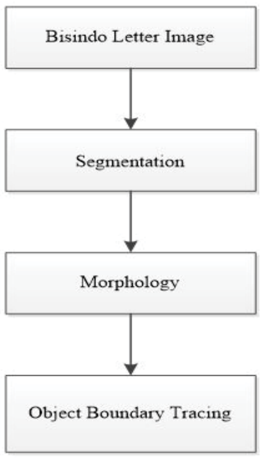

Fig. 1. Stages of edge detection for BISINDO Letters

A. BISINDO Letters

The inputted images were BISINDO letters image as many as 26 images (letter A to Z) with RGB image format. In BISINDO letters can be represented using one hand, i.e., C, E, I, J, L, O, R, U, V, Z while two hands, i.e., A, B, D, F, G, H, K, M, N, P, Q, S, T, W, X, Y [9]. The background used in this study was white. The image of BISINDO letter for a shown in Fig. 2.

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Fig. 2. BISINDO image for alphabet A

B. *Color Segmentation*

Image segmentation aims to represent an image area into numbers of pixels which are more meaningful and easier to analyze. Some researchers did color image segmentation [10]. A segment formation refers to properties:

- Pixels which were interconnected and have same color intensity value or same texture or high similarity will be grouped into the same segment.
- Pixels which were interconnected and have different color intensity value or different texture will be divided into 2 different segments and they were marked with boundary line.

The segmentation process was done by using color similarity measurement and using thresholding technique. Inputted image in the form of BISINDO hand pattern with RGB format and then it was done by determining threshold value and it was done by color distance measurement using RGB color space. Color distance for RGB color space was denoted mathematically (1), where R_1, G_1, B_1 and R_2, G_2, B_2 are Red, Green and Blue components for the first and second pixel.

$$\Delta E = \sqrt{(R_1 + R_2)^2 + (G_1 + G_2)^2 + (B_1 + B_2)^2} \quad (1)$$

Algorithm for Color Segmentation, as follows

1) Reading Bisindo letter image
2) Showing RGB image will be segmented
3) Reading of pixel color position
4) Determination of RGB space reference color and threshold value
5) Reading of RGB image size
6) Initialization matrix for RGB result image
7) Performing calculation for RGB color distance
8) Performing seperation of object with the background
9) Saving the RGB result image
10) Convert RGB result image to Grayscale image
11) Converting Grayscale image to Binary image
12) Showing RGB result image, Grayscale image and Binary image

C. *Morphological Closing*

Morphology or known as mathematical morphology is a tool to extract useful representation of image component and descript shape area [11]. The operator used was closing operator.

This operator was used to cover the gap or hole in the binary image at segmentation process. This was produced in previous stage. Morphological closing operation was denoted mathematically (2). The closing operation was a series of operation by the dilation operation and followed by erosion operation, where f is a binary image while B is a structuring element or a matrix size.

$$f.B = (f \oplus B) \ominus B \quad (2)$$

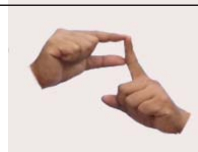
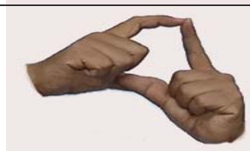
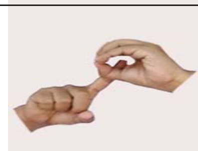
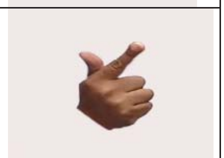
D. *Object Boundary Tracing*

The process was done for outside boundary tracing of an object and whole boundary in the object of BISINDO letters where outside boundaries of the object were marked in blue line while the whole boundaries in the object were marked in red line.

III. RESULTS AND DISCUSSION

Experiment was performed using 26 images of BISINDO alphabets, each letter represented letter A to Z. The original image for BISINDO letters (in RGB image column), shown in Table I and test results were performed in this study, shown in Table II.

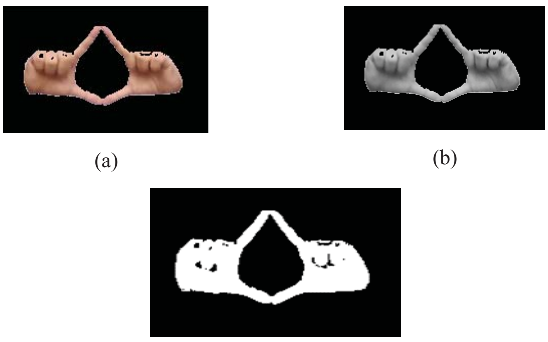
TABLE I. ORIGINAL IMAGES OF BISINDO LETTERS

Letters	RGB Image	Letters	RGB Image
A		N	
B		O	
C		P	
D		Q	
E		R	
F		S	
G		T	

Letters	RGB Image	Letters	RGB Image
H		U	
I		V	
J		W	
K		X	
L		Y	
M		Z	

Color segmentation process result of BISINDO image for letter A, shown in Fig. 3. Segmentation process result in form of binary image shown in Table II (segmentation column).

Segmentation process result was shown in Table II for segmentation process column by using 48 threshold value, while calculating each pixel in image using RGB color distance. If color distance was greater than threshold value, then object separation process with background was performed.



(a) (b)

(c)

Fig. 3. Result of Color segmentation process of BISINDO image for letter A (a) RGB Result Image, (b) Grayscale Image and (c) Binary Image

Morphology process result for closing operator of BISINDO image for letter "A", shown in Fig. 4.

Fig. 4. Morphology process result of BISINDO image for alphabet A

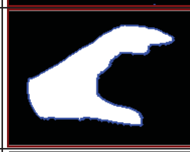
Morphological closing process result was shown in Table II. In this stage, image results of color segmentation were performed on previous stage in the form of binary image that would be processed. Structuring matrix kernel configuration used matrix of 5x5 with the value of each element was 1. The purpose of this stage was used to cover gap(s) or hole(s) in the binary image at segmentation process which was resulted in previous step.

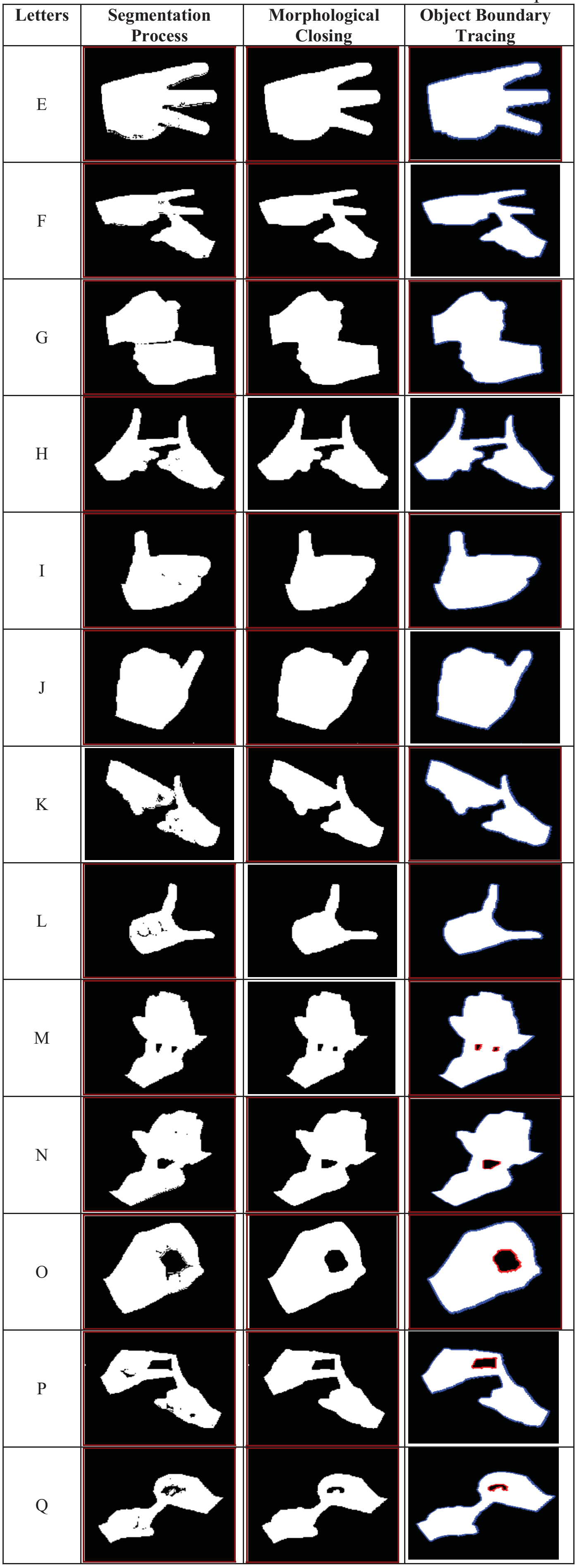
Object boundary tracing process result of BISINDO image for letter of A, shown in Fig. 5.

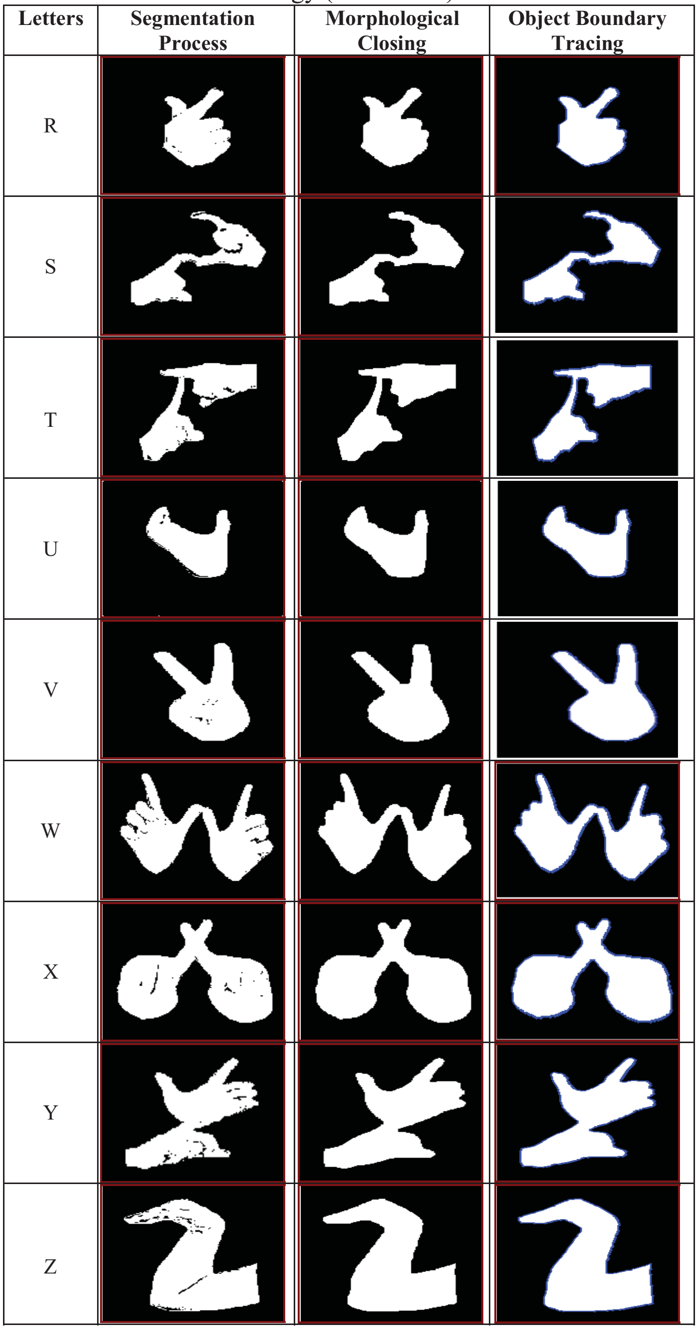
Fig. 5. Object boundary process result of BISINDO image for letter A

Object boundary tracing process result was shown in Table II for tracing boundary object column. In this stage, the obtained image results on morphological process in the form of binary image would be performed. Object boundary tracing process was performed by setting k value with 1 and calculate object edge boundary (N). If k value = 1 to the length of row and column coordinates of boundary pixels, then boundary = row and column coordinates of boundary pixels (k) while if k value was greater, then number of object boundary (k>N) then the object boundaries showed in blue color for the object and red color for the hole boundaries.

TABLE II. TEST RESULT FOR EACH OF STAGE

Letters	Segmentation Process	Morphological Closing	Object Boundary Tracing
A			
B			
C			
D			





IV. Conclusion

Methods and algorithms that were employed in this study was able to detect the edge of all 26 objects of BISINDO letters (Indonesian sign language) with recognition accuracy rate was 100%. Further research, we will conduct in real-time recognition.

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