Development of image extraction using the centerline method in the identification of appendicitis in ultrasonography

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ABSTRACT

Appendicitis is a disease that refers to inflammation of the appendix caused by obstruction, or blockage, in the lumen of the appendix. We investigated that this disease can be detected early through medical imaging such as ultrasonography (USG). However, the role of ultrasound in these cases is still limited due to the low visualization rate of the visible appendix. Based on this, this research aims to develop an image extraction process using the Centerline method in the process of identifying appendicitis in ultrasound images. The development of the extraction process is presented in the performance of the centerline and boundary extraction (CBE) algorithm which can represent image objects as boundaries that limit and separate one area from other areas. The research dataset used was 2097 ultrasound images sourced from 90 patients at the West Sumatra Lung Hospital. Based on the tests that have been carried out, it has been proven that it can reduce the width of the image object iteratively until the object is represented as a center line or the thinnest representation. The performance of the CBE algorithm in the identification process is sufficient to provide accuracy results of 92%. These results can be a new extraction concept that can provide accuracy in the identification process.

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1. INTRODUCTION

Appendicitis is a disease that can be referred to as appendicitis and is a well-known, common, and painful abdominal surgical emergency [1]. This disease can be caused by obstruction, or blockage, in the lumen of the appendix, resulting in parts experiencing changes and continuing to increase the pressure in the lumen of the appendix [2]. Based on this, the use of technology is expected to be able to provide support in early diagnosis of appendicitis [3]. Medical technology has provided a positive role in several cases in assisting the diagnosis process [4].

Previous research explains that the use of ultrasound technology can be used as an aid in decision-making in a more accurate diagnosis process [5]. Furthermore, similar research also reports that medical technology has helped to test the correlation of the accuracy of diagnostic results in acute appendicitis with examination of clinical symptoms suspected of appendicitis [6]. Similar research also shows that visualization of the appendix using medical technology can improve and enable the process of correctly diagnosing appendicitis [7].

One use of medical technology can be seen based on the performance of ultrasonography (USG) technology. The use of ultrasound can provide support for the identification process to maximize the diagnosis process [8]. Ultrasound images have also been able to facilitate the process of identifying diseases that are difficult to detect [9]. Based on this, ultrasound images also still have shortcomings and limitations caused by the level of visualization in the appendicitis identification process [10].

Improving the performance of ultrasound images is very much needed in optimizing the diagnosis process, which can be seen from the performance of image processing concepts [11]. Image processing has contributed a lot in dealing with the problems of object detection, identification, and prediction [12]. The implementation of image processing concepts in the appendicitis identification process has also provided several novelties to support the diagnosis process [13]. Previous research reported that the use of digital image processing proposed an automatic extractor in the diagnosis of appendicitis presented 1 failure out of 45 cases of trials that had been carried out [14]. Other research also explains that the role of AI in the appendicitis identification process also provides results with a fairly good level of accuracy [15]. Another study also stated that an unsupervised cooperative machine learning approach for the problem of appendicitis identification provided a result accuracy of 96.25% with improvements in the performance of the edge detection process [16].

Based on previous research, this research will also focus on the process of identifying appendicitis by using the extraction process in an image-processing concept. The performance of the extraction process by utilizing several methods can provide quite good results in the identification process [17]. Image extraction performance has actively contributed to the process of diagnosing appendicitis objects [18]. The diagnosis of appendicitis object cases can also be seen based on the performance of a convolutional neural networks (CNN)-based algorithm in diagnosing acute appendicitis using computed tomography (CT) data presenting a validation rate of 90% [19]. The same research also explains that the appendicitis identification process can also be carried out using the archimedes optimization algorithm (AOA) which has better performance in extracting error characteristics from simulated cases and actual cases [20]. Development of an extraction process using the CNN EfficientNet algorithm for automatic classification of acute appendicitis, acute diverticulitis, and normal appendicitis presented an accuracy of 93.62%, a sensitivity of 92.35%, and a specificity of 95.47% [21].

Based on this explanation, the extraction process can be developed in this research to produce more precise and accurate identification results. The development of the proposed extraction process adopts the performance of the Centerline method in identifying appendicitis on ultrasound images. The performance of the previous centerline method was able to be developed on the performance of the centerline and boundary extraction (CBE) algorithm. The CBE algorithm is an algorithm developed to represent image objects as boundaries that limit other image areas. The development of the extraction process carried out using the CBE algorithm is able to present new, effective, and efficient identification processes. The proposed innovation can also have an impact on the development of medical technology in the process of diagnosing appendicitis.

2. METHOD

The process of identifying appendicitis objects is carried out by developing an extraction process that involves the performance of the centerline method in the CBE algorithm. The development of the CBE algorithm is aimed at maximizing the identification process by playing with boundaries to limit the area of the identification object from other objects. The performance of the CBE algorithm in the presentation process is presented in the research framework. An overview of the framework can be seen in Figure 1.

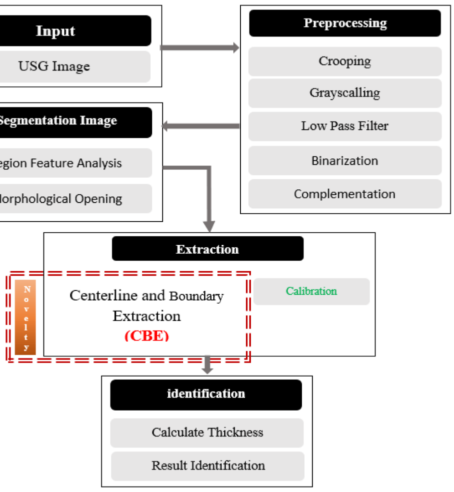


Figure 1. Research framework

Figure 1 shows the performance of the centerline method process developed with the CBE algorithm in identifying appendicitis objects. The performance of the CBE algorithm is expected to be able to present a new algorithm that is effective and efficient in the process of identifying image appendicitis. The identification process is divided into several stages which can be explained as follows:

a) Preprocessing stage

The preprocessing stage is the initial stage before the object identification process is carried out. This stage involves several processes including cropping, gray scaling, filtering, binarization, and complementation. The preprocessing output results will be continued at the image segmentation stage.

b) Segmentation stage

The segmentation stages in this research are part of the identification work process used on appendicitis objects. The segmentation process involves performing morphological segmentation with several operations such as opening and closing as well as the region feature analysis process. The segmentation results will be able to provide results with the presentation of objects that have begun to separate to provide an initial picture of the object of appendicitis.

c) Extraction stage

The extraction stage is a stage in the identification process where the centerline method will be developed using the CBE algorithm. The CBE algorithm plays the role of boundary objects as a basis for identification. The CBE performance results can reduce the width of the object to the center line or the thinnest representation. Furthermore, calibration in the context of image processing or computer vision refers to the process of correcting or compensating for distortions that may occur in images, especially camera distortion. The goal is to produce more accurate and consistent images, enabling more precise measurements and analysis.

d) Identification stage

This identification stage is the final stage to provide results that can be used as a diagnosis of the object of appendicitis. This stage will carry out calculations using calculate thickness to determine the size of the distance or thickness of the appendicitis. The distance obtained from the center line to the object boundary. The identification output results can provide accuracy in the process of diagnosing appendicitis.

2.1. Dataset

This research dataset uses appendix ultrasound image data in the form of *Jpg format files. This dataset was sourced from the West Sumatra Lung Hospital for those diagnosed with appendicitis. Categories of patients who are positive for appendicitis have different forms of inflammation. An overview of the ultrasound image research dataset of appendicitis patients can be presented in Figure 2.

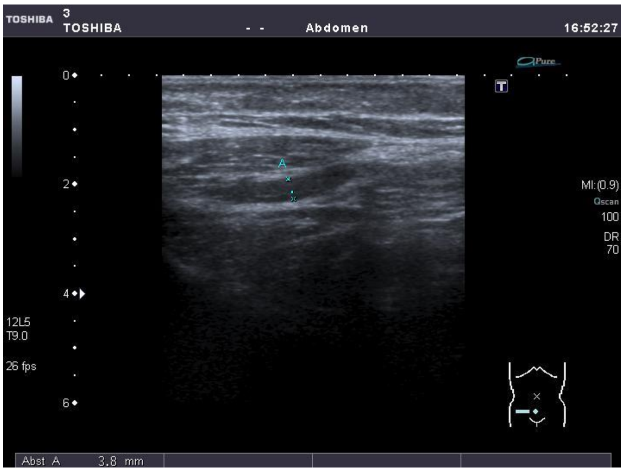


Figure 2. Research dataset of appendicitis

2.2. Centerline extraction

A centerline is part of a geometric shape where each centerline point is at the same distance [22]. Previous research explains that centerline can be used as a form of process to increase accuracy in identification by developing a new thinning algorithm based on environmental statistics [23], [24]. An overview of the centerline method process can be presented in Figure 3 [25].

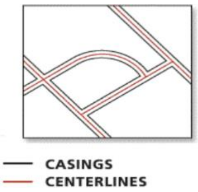


Figure 3. Centerline method process

Figure 3 is an illustration of the center line method for thickening the target line object. In concept, center line extraction or center line extraction can be used in the process of identifying and extracting center lines from objects or structures in images [26]. This process is generally carried out by measuring the center line of an object using (1) [27].

$$\mathcal{E}_{centerline}(C) = \int_{0=C^{-1}(P0)}^{L=C^{-1}(P1)s(P1)} F\big(C(s)\big)ds \quad (1)$$

In (1) explains that the measurement of the center line with *E_centerline (C)* can be seen based on the scalar field (*Fx*) which is lower than the other points. The decrease in the functions *p1* and *p2* contained in the formula can be related to the distance from an object [28]. The distance transformation derivative function can be presented in (2) [29].

$$DT(x) = \frac{min}{y \in \partial\Omega}\{|x, y|\} \quad (2)$$

In (2) is an equation used in measuring distances involving Euclidean. This equation can also show the position of a center point or a line [30]. Based on this formula, the process of thickening the parts of an image object will be able to provide accurate identification results.

3. RESULTS AND DISCUSSION

The appendicitis identification process which is based on the development of the centerline method with the CBE algorithm is presented in several stages. The identification process begins with a preprocessing stage aimed at improving the input image. The results of the preprocessing can be presented in Figure 4. Figure 4 is a series of preprocessing processes for identifying appendicitis. Based on the tests carried out, it can be seen that Figure 4(a) is the input image used in the identification process. Figure 4(b) displays the results of the cropping process as an initial sequence in preprocessing. Figure 4(c) is a display of the results of the greyscalling image transformation process. The results of the greyscalling image are used again in the filter process by playing low-pass filtering which is presented in Figure 4(d). The results of the filtering process become input in the binarization process which aims to change the pixel values in the binary image presented in Figure 4(e). The final stage of preprocessing will be closed with the complementation process presented in Figure 4(f). Overall, preprocessing gives quite good results so that the identification process will continue with the segmentation process. The segmentation process can be presented in Figure 5.

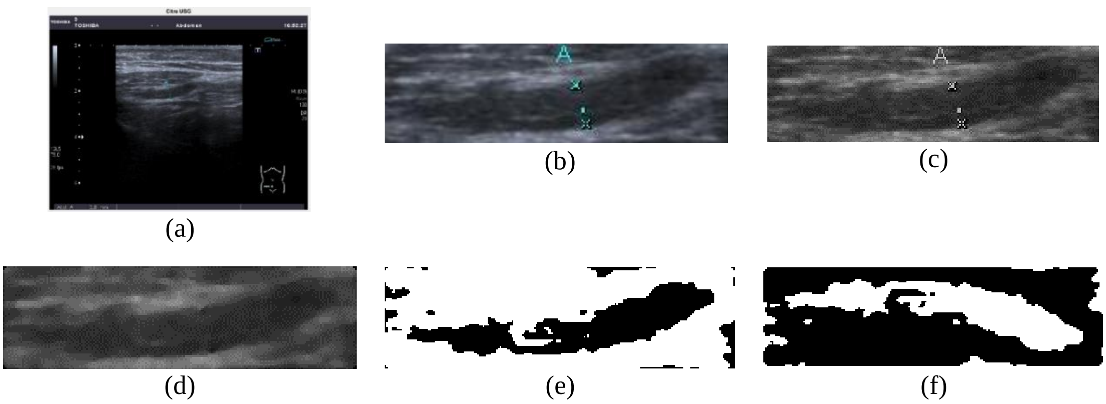
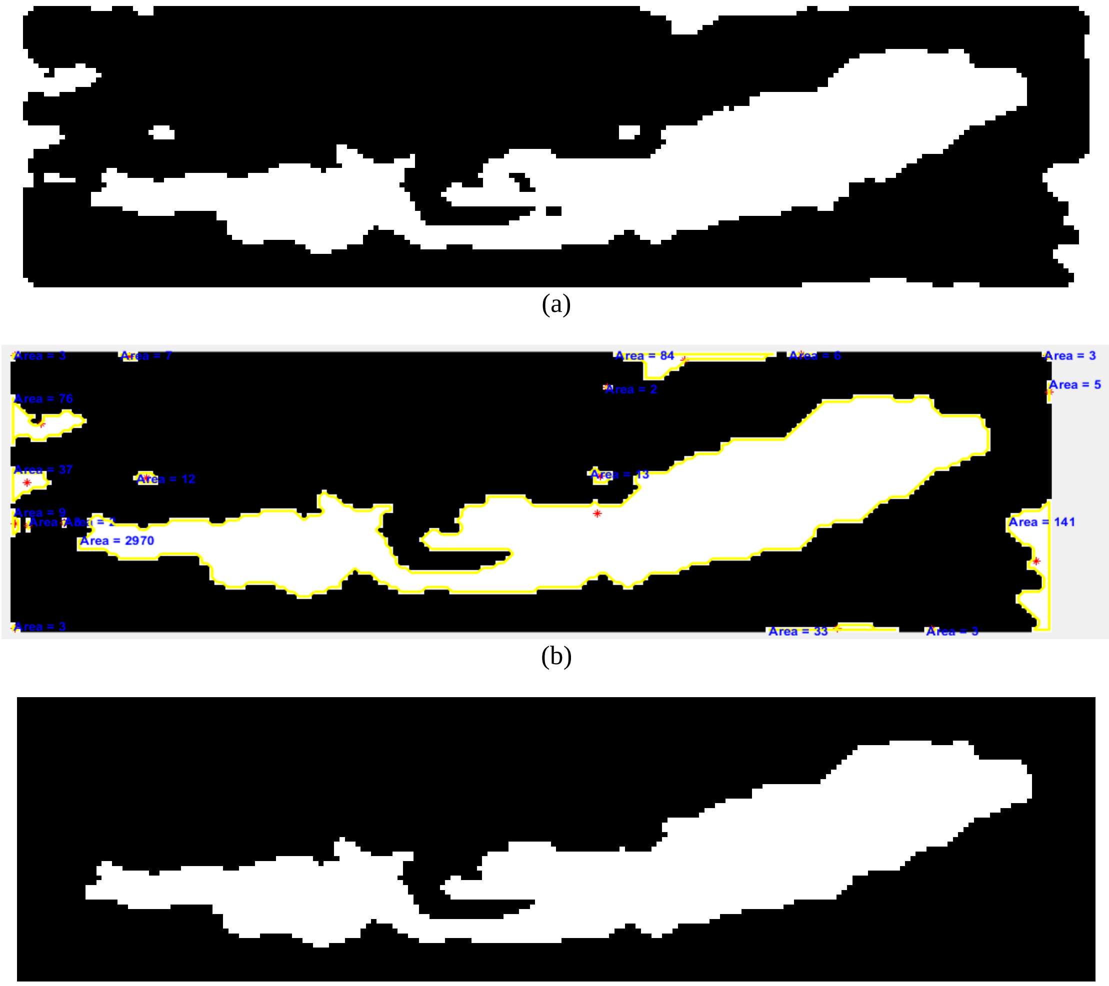


Figure 4. Preprocessing result: (a) input image, (b) cropping result, (c) grayscalling result, (d) low pass filter result, (e) binarization result, and (f) complementation result

Figure 5 is the result of the segmentation process in identifying appendicitis in ultrasound images. Figure 5(a) is an image resulting from previous preprocessing which is reused to present an image of an appendicitis object. Figure 5(b) is the result of segmentation which includes regional feature analysis to obtain knowledge about image object information such as area size and number of pixels in an area. Figure 5 (c) is the output of segmentation results using opening morphology. The purpose of opening morphology segmentation is to remove other objects. Based on the segmentation process that has been carried out as a whole, it is proven that the segmentation results can provide a fairly clear picture of the object.



(a)

(b)

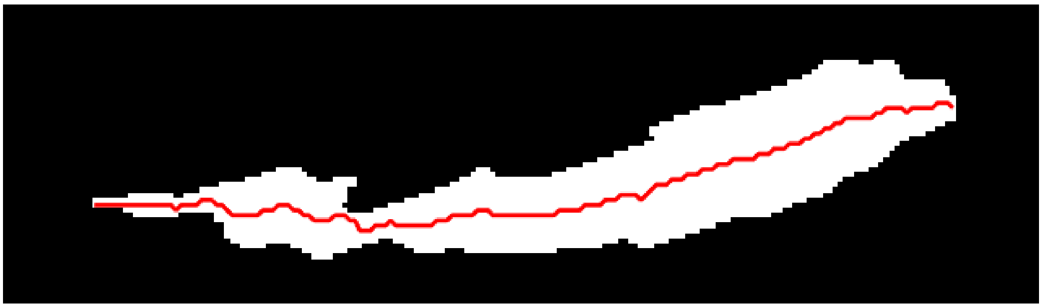
(c)

Figure 5. Segmentation result: (a) preprocessing result, (b) region feature results, and (c) opening morphology segmentation results

After the segmentation process presents an image of the object, the extraction process is carried out using the extraction process. The extraction process will later develop a centerline method using the CBE algorithm. The performance of the CBE algorithm involves representing objects in the image as boundaries or lines or surfaces that limit or separate one area from other areas. The boundary object is divided into two, namely topRows and bottomRows. The centerline is obtained from the mean of top rows and bottom rows. The performance results of the CBE algorithm can be presented in Figure 6.

Figure 6 shows the performance results of the CBE algorithm in obtaining line images formed by providing boundary line images based on object boundaries. Figure 6(a) is the result of segmentation that has been carried out previously to present the object of appendicitis. Figure 6(b) shows the performance of the CBE algorithm in providing an overview of appendicitis identification objects to describe the presence of objects between the top and bottom rows. CBE's performance has presented quite good results in the object image extraction process. The results of the overall appendicitis object identification process can be presented in Figure 7.

(a)



(b)

Figure 6. CBE algorithm extraction results (a) segmentation results and (b) CBE algorithm result

Figure 7 is the result of the appendicitis object identification process which was carried out using the CBE algorithm. These results can be seen that the detection object is quite precise with the centerline image that is formed. After the CBE performance can be seen based on Figure 6, the CBE algorithm testing process aims to measure the resulting performance. The testing process was carried out by comparing the results of medical diagnoses on several previous datasets. A sample form of testing can be presented in Table 1.

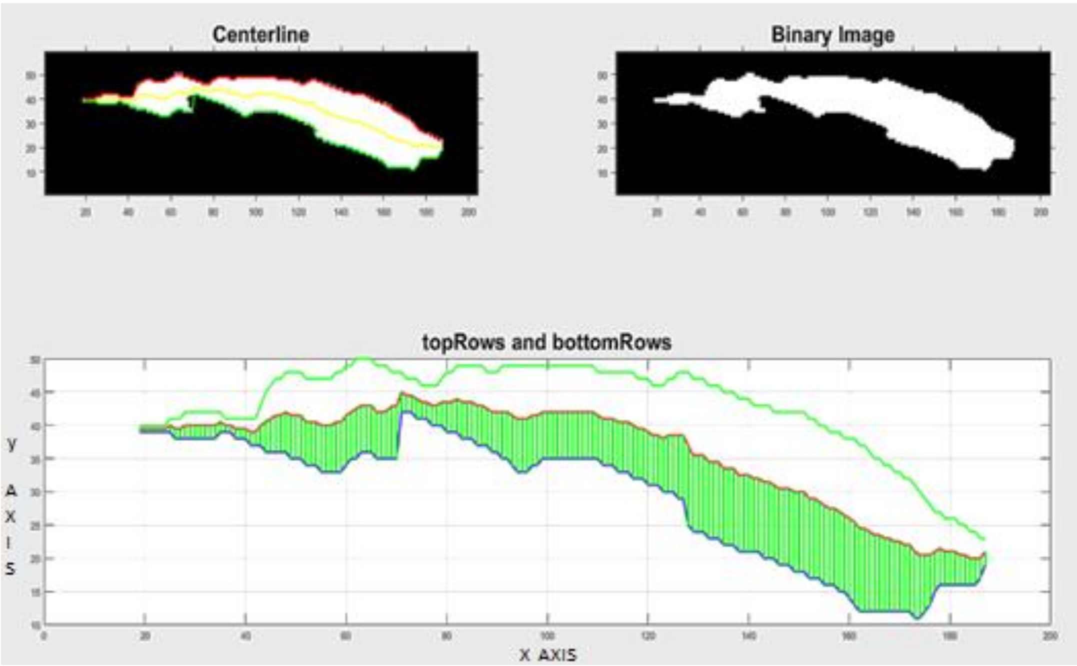


Figure 7. Results of the appendicitis identification process using the CBE algorithm

Table 1. CBE algorithm testing

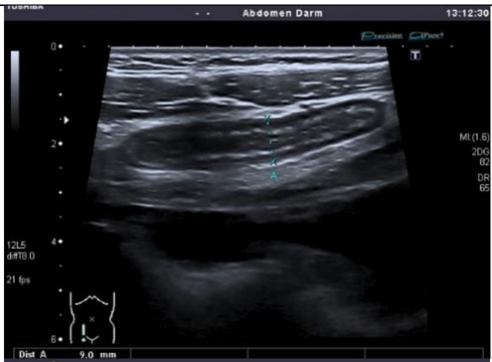
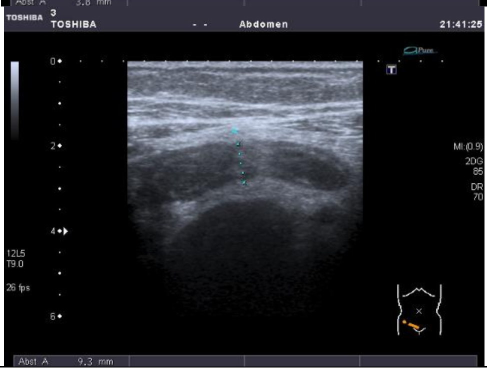
Patient	USG Image	Maximum Distance	Identification Results CBE	Medical Diagnosis	Accuracy
1		9.1	Positive	Positive	100%
2		3.8	Negative	Positive	0%
3		9.3	Positive	Positive	100%

Table 1 is a form of CBE algorithm testing in measuring accuracy performance in the identification process. Based on tests carried out on the research dataset, it was found that the performance of the CBE algorithm provides an accuracy level of 92%. These results are based on several 83 patients identified and 7 who were not correctly identified.

Based on these results, the extraction process developed with the CBE algorithm has provided precise and accurate identification results. The performance of the CBE algorithm can provide novelty in an effective and efficient algorithm for image extraction in the identification process. This novelty is also able to have a quite good impact on the development of medical technology in the process of diagnosing appendicitis. Based on these results, research in the process of identifying appendicitis disease has considerable potential to develop in the future. This is based on the effectiveness of digital image processing performance in the world of health, increasingly helping work in the diagnosis process.

4. CONCLUSION

The process of identifying appendicitis objects by developing image extraction using the CBE algorithm has provided quite good results. These results have been proven to be able to provide precise and accurate identification results with an accuracy level of 92%. The results of CBE performance are also able to provide a quite effective role in supporting medical performance in making diagnoses by presenting inflammation measurements based on the normal limits of appendix size. Overall, this research has been able to contribute to helping medical parties in the process of identifying appendicitis.

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