Ultrasound Appendix Image Segmentation Using Histogram Thresholding and Image Enhancement Using Noise Filtering Technique

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Abstract – Ultrasound screening is preferably applied because of its nonionizing feature. This is very convenient to the patient especially for the pregnant patient to avoid casualty to the infant. However, the raw ultrasound image is not clear enough to identify a disease effectively. And it also has the limitation on positive detection to diagnose especially the appendicitis. To counter attack this problem, this paper presents an image processing method to get a more satisfying result by compromising image segmentation and image enhancement technologies. To segment out the image, histogram thresholding is used and edge detection method is applied to enhance the image quality. Appendix outline is detected through computerized algorithm in MATLAB® to find the measurement of its parameter. The pixel value of the appendix outline was extracted and used as the weighted terms for parameter calculation. From the results, it can be said that this method could extract the appendix from ultrasound image and so, that finding is useful for examiner to do parameter measurement.

Keywords – ultrasound, image segmentation, image enhancement, appendix, histogram thresholding, edge detection.

1 Introduction

CT scan had been found more reliable to diagnosed for appendicitis in pregnant patient, however the radiation exposure during the diagnosis double the risk to develop a fetal cancer which in turn makes ultrasound screening(US) as the preferable method to examine for appendicitis in pregnant patient [2]. However, a study for US exam in 33 pregnant patient shows 88% failure on detecting the pathologically proven having appendicitis. A study to compare MRI and US on reliability to detect appendicitis shows that MRI correctly diagnosed 33 of 34 cases (97%) of acute appendicitis as compared to US [2]. So US correctly diagnosed appendicitis lower than MRI [3].

However, ultrasound is a nonionization method for scanning which is very useful for pregnant patient. Hence, the poor ability of ultrasound to find appendicitis is solemnly the limitation of the US hardware itself. Upgrading parts, system and hardware might help to enhance the detection for organs inside the body.

Apart from that, nonvisualized image when examining can be counter attack by image processing. Clearer image can be obtained by undergo some image processing on the blurry image which in turn can help in better visualization for accurate diagnosis and interpretation by the specialist or medical doctor.

This paper describes the enhancement of medical ultrasound image mainly for appendicitis. This can be achieved by undergo some methods on image processing. They are:

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1) Medical image segmentation.
2) Image enhancement.
3) Parameter measurement.

There are a lot of methods to achieve the objectives, however only one method is used for each stated objective for better result. For medical segmentation purpose, histogram thresholding method is used. Averaging noise filtering 3X3 kernal method is implemented in image enhancement. Finally, image labeling and area pixel selection method is used for parameter measurement.

2 Literature Review

The appendix is an appendage or appendix like structure. It is a wormlike intestinal diverticulum extending from the blind end of the cecum; it varies in length and ends in a blind extremity [7].

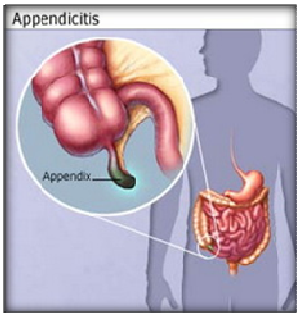
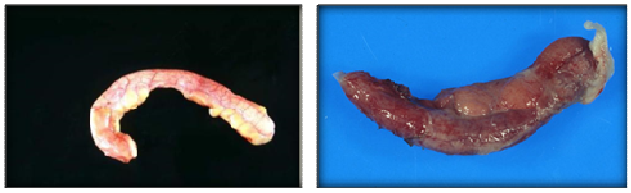


Fig. 1: appendix anatomy

The appendix is part of the cecum from which itoriginates where the 3 tenia coli coalesce at the distal aspect of the cecum. Not surprisingly, the appendix resembles the cecum histologically and includes circular and longitudinal muscle layers. The appendix arises from the cecum approximately 2.5 cm below the ileocecal valve. It varies in length from complete agenesis to more than 30 cm, but it is usually 5 to 10 cm in length. The mean width is 0.5 to 1.0 cm [6].

The main thrust of events leading to the development of acute appendicitis lies in the appendix developing a compromised blood supply due to obstruction of its lumen and becoming very vulnerable to invasion by bacteria found in the gut normally. Obstruction of the appendix lumen by faecolith, enlarged lymph node, worms, tumour, normal mucus secretions continue within the lumen of the appendix or indeed foreign objects, brings about a raised intra-luminal pressure, which causes the wall of the appendix to become distended, thus causing further build up of intra-luminal pressures [8].



(a) (b)

Fig. 2 (a) normal appendix,(b) appendix inflammation

By using ultrasound to diagnose appendicitis, visualizing still remains a difficulty. A normal appendix is hard to be detected in ultrasound image so any visualize appendix in ultrasound image is considered as abnormal [9]. The same evaluation is true for the patient with obese.

In this paper, two image processing methods will be discussed namely image segmentation and noise filtering methods.Image segmentation frequently used to aid in isolating or removing specific portions of an image. Some examples for image segmentation are graph cuts, normalized cuts, and mean shift [10].Denoising or noise filtering method can be differentiated into two types. They are linear filtering and nonlinear filtering. Example of linear filtering is mean filter and LMS adaptive filter whereas the example for nonlinear filter is median filter [10].

The graph cuts method is good for medical and scientific imaging where we are looking to segment very specific items from many images. The normalized cut method and mean shift method are both better suited for automatic segmentation. Both can achieve an over-segmentation of the image into “super-pixels” or a segmentation that divides the image into only a few main regions, hopefully picking out the main objects [10].

From the experimental and mathematical results [11] it can be concluded that for salt and pepper noise, the median filter is optimal compared to mean filter and LMS adaptive filter. It produces the maximum SNR for the output image compared to the linear filters considered. The LMS adaptive filter proves to be better than the mean filter but has more time complexity. From the output images, the image obtained from the median filter has no noise present in it and is close to the high quality image.

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The sharpness of the image is retained unlike in the case of linear filtering.

Among them histogram thresholding method for image segmentation and median filter method for image noise filtering are experimentally tested and discussed in this paper. Based on the faster time in the process of obtaining the output and the ability to obtain clearer image in medical aid for better evaluation, this selection was made.

3 Material and Methodology

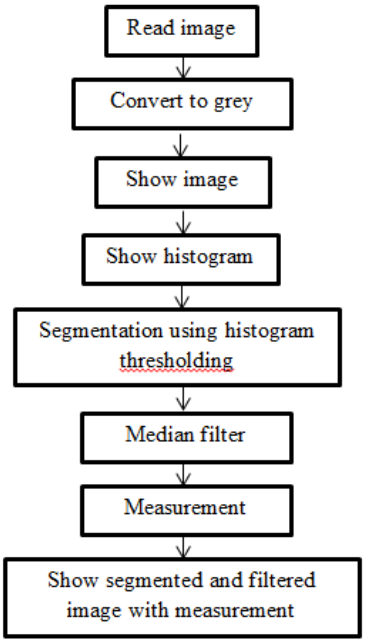

Fig.3 Process Flow Chart

Figure shows the overall process implementation in this paper.First of all, the medical image of appendix is load to the matlab workspace. Then, the image is converted to grey image. This is useful if colors are present in the medical image. This is also to make the image to be easily processed later on. After that, showing the medical image and histogram is optional. This is just to see the effect done to the image by the function earlier and can be neglected if needed. The next step is to do image segmentation using histogram thresholding. This is to divide the image into its constituent region or object. Next median filter is performed. This step will filter the noise so that the image is clearer. Finally, measurement can be done to calculate the appendix parameter using some formula and the result can be displayed.

Currently, there is no effort in image enhancement for appendicitis ultrasound image. This is due to the availability of other medical screening that can replace ultrasound which in turn can give more satisfy result as well as higher probability on positive appendicitis detection. However, using ultrasound is still the preferable methods to use for appendicitis detection for its nonionizing feature which suitable for all age, gender and physical limitation. Hence, the limitation can be counteracted by doing some image processing on the medical images which are being done in this study.

4 Result and Discussion

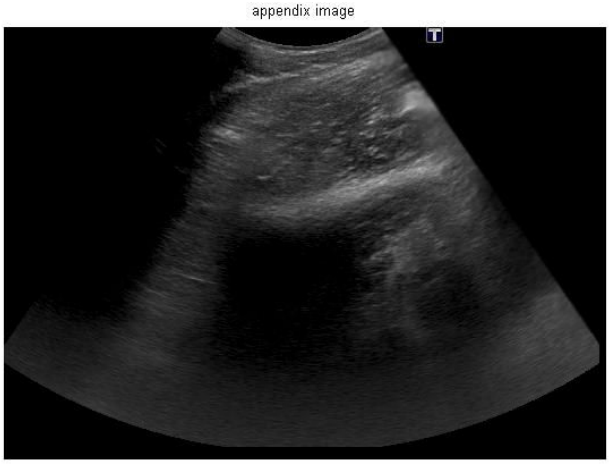

Fig. 4: Original Ultrasound Image of Appendix

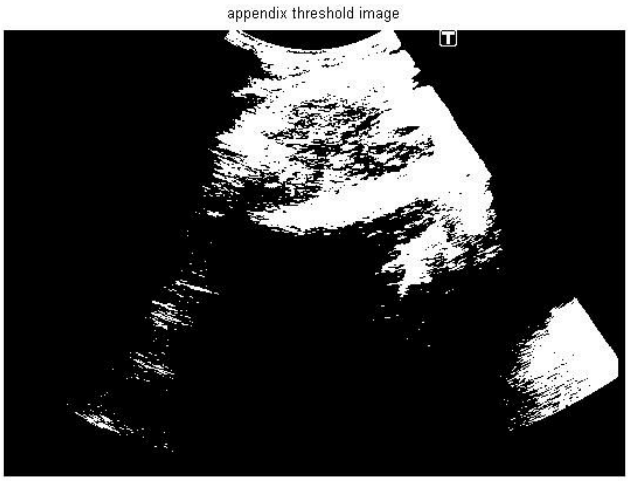

Fig. 5: Illustration of Appendix Image after Thresholding Image

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Fig. 6: After Edge Detection of Thresholded Appendix Image

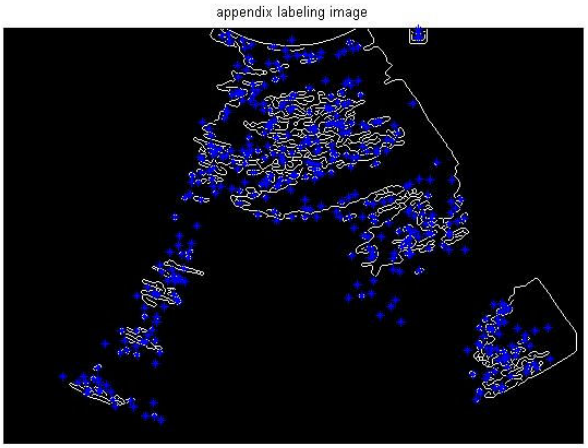

Fig. 7: After labeling of Edge detected Image

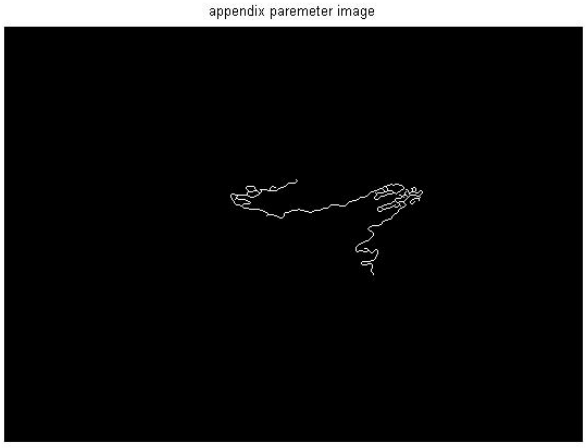

Fig. 8: After parameterising Labeled Appendix Image

The raw appendix image is shown in Figure 4 and Figure 5 through 8 depicts the step by step image processing.

From these figure it can be said that the implemented process can detect clearly the outline of the appendix. This can make the evaluation easier by calculating the distance of the appendix. However the whole appendix cannot be detected. Some region of the appendix had been cut off due to the discontinuity of the pixel in the image after edge detection. This may be due to the poor image quality that captured by the ultrasound and inappropriate use of probes when examining which in turn give a low quality and blurry image. These factors highly affected the image.

It can be recommended that if a better quality of image is used, a more satisfying output result could be get. The implemented method can be used not only in the detection of appendix but also in iris identification recognition, tumor relocation and so on.

5 Conclusion

A new approach on ultrasound appendix image processing using image segmentation and image enhancement had been developed. The project successfully enhances the medical ultrasound image mainly for appendicitis. This is achieved by undergone the methods specified on image processing namely medical image segmentation, image enhancement and parameter measurement

The result shows the detection of the appendix in ultrasound image. The outline of the appendix is clearly seen at the end of the process. This is convenient for the examiner. From the detection, measurement can be done to calculate its length. Examiner can indicate the appendix parameter measurement that is display on the image.

6 Future Extension

This method can be used on other application not only on appendix but also on the application for iris identification recognition and tumor recollection or detection. Whereby the iris can be outlined with this method to indicate it's parameter for identification recognition. This is also applicable to the tumor detection where the tumor too can be outlined with this method for better evaluation by the examiner on the tumor location.

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