2P5-5

Accuracy Assessment in Self-Measurement for Continuous Monitoring of Breast Tumor Volume

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1. Introduction

When detected early, breast cancer treatment can be less burdensome, and survival rates can potentially improve. While biennial breast cancer screenings are recommended in Japan, many individuals still experience significant physical and emotional stress during these screenings. When a tumor is found but cannot be clearly identified as benign or malignant, patients often undergo a period of observation lasting several months to a year, followed by a rescreening. During this time, patients typically harbor anxieties about the nature and growth of the tumor. It appears that the current breast cancer screening system in Japan might not adequately address the potential decline in patients' quality of life (QoL) during this period.

Ultrasound is widely used as a non-invasive tool to visualize the internal structures of living organisms. If patients could use ultrasound at home to monitor their tumors, it might alleviate some of the anxieties associated with the observation period. The goal of this study differs from those using AI for breast cancer detection and evaluation. Instead, it aims to automatically determine tumor changes over time from ultrasound images. Given that the tumor's location is already known from breast cancer screenings, there's no need to decide on the tumor's presence or nature.

To capture a tumor's three-dimensional structure, two-dimensional cross-sectional images are typically taken while moving an ultrasound probe. These images are then used to automatically extract the tumor and reconstruct it in three dimensions. However, because the movement and angle of the probe might vary, the resulting three-dimensional structure could differ. In this study, we assess the variability in tumor volume using commercially available ultrasound probes and a biological phantom model.

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2. Method

2.1 Experimental setup

The ultrasonic imaging diagnostic device, Vivid7 Dimension (GE Healthcare Japan Corp.), in conjunction with the linear probe L11-4 (GE Healthcare Japan Corp.), was used for image acquisition. This probe was affixed to the XY automatic stage (SIGMAKOKI Co., Ltd.) and moved at a speed of 3 mm/s while the biological phantom, BREAST FAN (Kyoto Kagaku Co., Ltd.), was scanned. Videos were recorded at a rate of 26 fps, and approximately 100 images were captured in each session. This procedure was repeated 10 times.

2.2 Evaluation

Figure 1 shows a flow diagram of the processing procedure. Using this procedure, volume estimation was conducted from the captured video. From the results of the volume estimation, the mean, standard deviation, and coefficient of variation were calculated to assess the degree of variation in the volume estimation values.

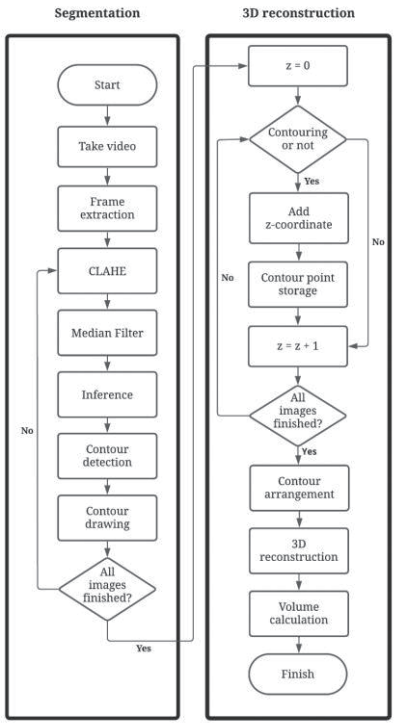

Fig. 1. Flowchart of processing.

3. Result

As a result, the estimated average volume was 0.874 cm^3 with a standard deviation of 0.146 cm^3 (16.7%). **Figure 2** shows the estimated volume and its average. From these findings, it was suggested that there's a 16.7% variability in volume estimation. Two primary causes for this variability can be considered. The first is measurement error. Because the ultrasound probe was manually held during scanning, variations in the movement speed and angle of the probe for each measurement are believed to have influenced the estimation results. The second cause is related to the segmentation process and its preceding treatments. For preprocessing the ultrasound images, both CLAHE and median filter were applied. Subsequently, inference was carried out using the U-Net model. However, despite the evident presence of tumors, segmentation was not accurately achieved in approximately 10 images. These misjudgments are believed to have contributed to the variability in volume estimation.

4. Conclusion

In this study, three-dimensional reconstruction was performed using multiple cross-sectional images obtained by scanning with an ultrasound device, and the variability in volume estimation was evaluated. As a result, it was confirmed that the variation in volume estimation was 16.7%. In the future, we plan to improve the experimental method to reduce measurement errors. This will allow for accurate assessment of variation due to volume estimation. It may contribute to better follow-up for breast cancer patients and reduce the strain on medical resources.

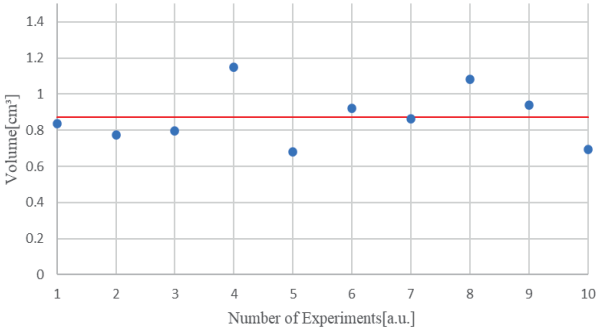

Fig.2. Estimated volume (blue points) and mean values (red line).

References

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