A Study on the same cross-sectional tracking method using AEMADP++ based on YOLACT++ for autmated diagnostic and therapeutic robots

Abstract

One of the problems that HIFU treatment has not been automated is the inability to apply ultrasound to the target cadaver for a long period of time due to organ movement caused by respiratory motion. To solve this problem, we proposed AEMADP++ (Angle Estimation Method by Area and Dialog plus Pancreas++) based on YOLACT++, which has high estimation accuracy for long-axis images. We believe that AEMADP++ can be used for robot tracking in the long-axis cross-sectional images of the target organs. In the future, we aim to improve the estimation accuracy in short-axis images.

Backgrounds

High Intensity Focused Ultrasound(HIFU)

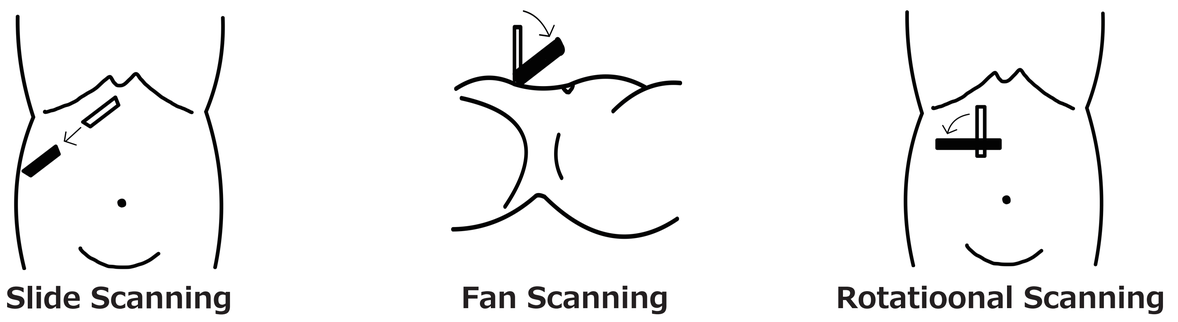
- Treatment is possible without opening the abdomen, reducing the burden on the patient.
- Non-invasive due to the use of ultrasound
- Currently used for prostate cancer and stones.

Problems

When used in the treatment of kidney and liver cancer, it is difficult to focus on the affected area for a long period of time due to the movement by breathing.

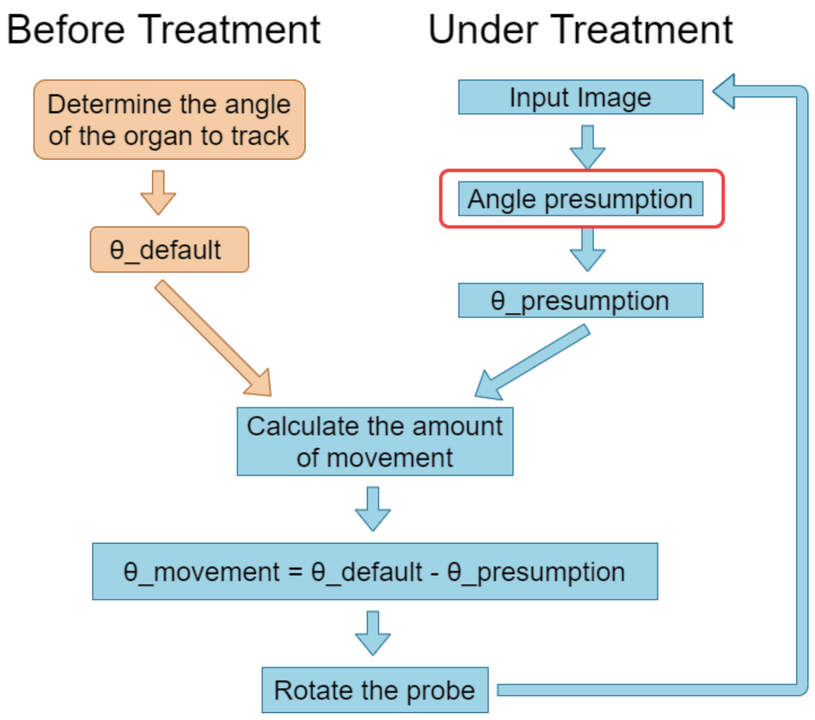
Purpose

Development of a system to track the same cross section of a diseased part undergoing three-dimensional variation in rotational scanning and proposal of a method to estimate the angles of organs in ultrasound images.

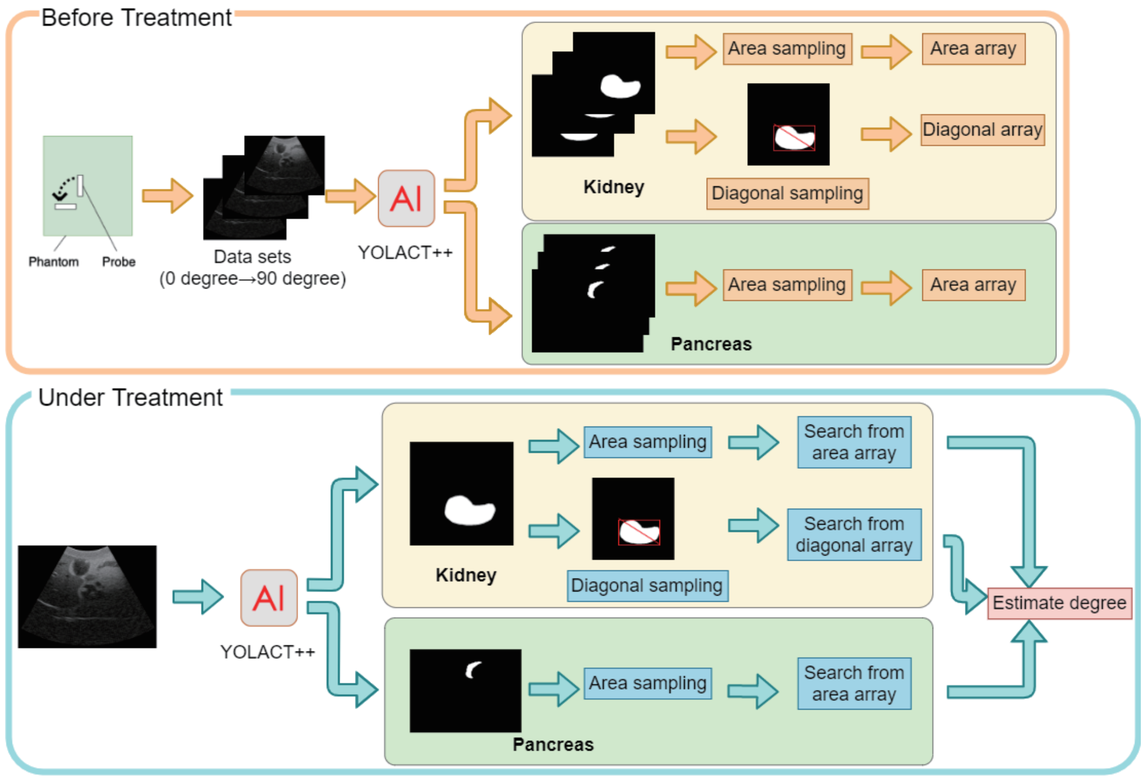


Proposed Methods

Tracking system for rotational scanning



Angle Estimation Method by Area and Dialog plus Pancreas++(AEMADP++)

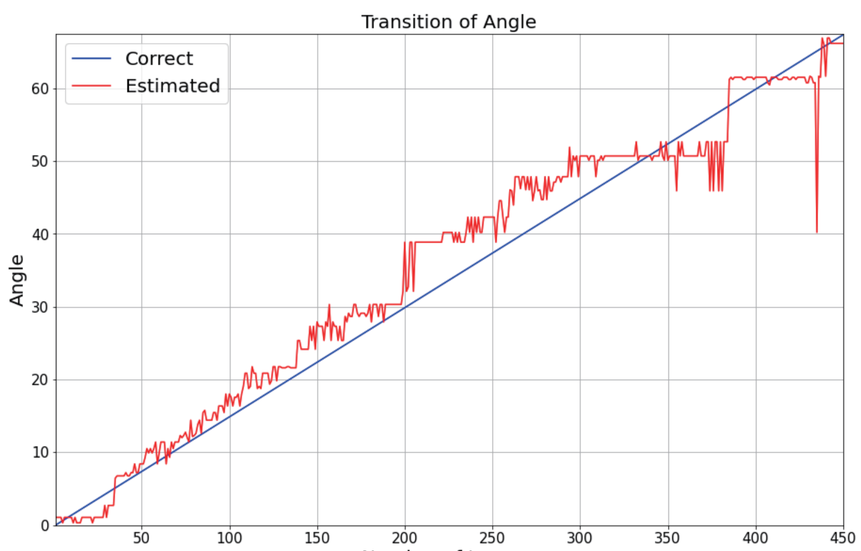


Experiments

Methods

- YOLACT++ trained with 600 sheets in advance
- Target organ is the right kidney of the ultrasound phantom (ABDFAN)
- A total of six data sets used in the experiment 450 consecutive images from 0 to 67.5 degrees, respectively
- Angle estimation by the proposed method for each image in the dataset

the ultrasound phantom (ABDFAN)



Results

- Accuracy 48.7%, mean error 4.73 mm at ±2.5 degrees tolerance
- RMASE 3.88, R^2 0.960, About 2.5FPS
- 88.1% correct from 0 to 10 degrees for a tolerance of ±2.5 degrees

許容誤差	評価指標	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	all
0度	平均誤差(mm)	1.46	2.04	2.92	5.90	3.90	3.07	2.07	3.09
	正解率(%)	2.99	2.99	1.49	1.49	1.49	1.49	13.2	0.889
±2.5度	平均誤差(mm)	2.85	3.29	3.91	6.11	4.49	4.58	5.50	4.73
	正解率(%)	88.1	70.1	41.8	6.0	20.9	47.8	79.2	48.7

Conclusions

- AEMADP++ can estimate angles with an accuracy of 0.15 degrees, and the estimation accuracy of the long axis image is 88.1%.
- We believe that it is possible to follow the long axis image of the kidney by using AEMADP++ as an angle estimation method.

Future Prospects

- Improvement of angle estimation accuracy of short-axis images by adding information on peripheral organs as new features
- Fast segmentation model application

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