Lab 2 - Breast Boundary segmentation using MevisLab

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I. INTRODUCTION

In this lab, we first got familiar with the structure and filters of Mevislab, and then knew about how to use Mevislab to process DICOM images with the graph coding framework. Based on that, we developed an automatic breast boundary segmentation system, which can be applied to almost all the breast images.

II. BREAST BOUNDARY SEGMENTATION

As we know, image segmentation is still a tough topic in the area of computer vision. Compared with normal image segmentation, the segmentation of medical images is more difficult because of the complicated structures of different part of human body. The 3D volume of medical images (e.g. MRI) significantly increase the amount of the information and the computing speed. Whole segmentation procedure is shown as follows, and we will analyse line by line in detail

(a) Load an image.

(b) Normalise the image volume.

(c) Median filter and Gaussian filter.

(d) Get an image which is the mean of the volume.

(e) Resample a volume where all the slices are the same.

(f) Get the binary volume with a certain threshold.

(g) Morphological operation (closing).

(h) Get the segmentation results.

The type of DICOM image value is unsigned int16, whose range is from 0 to 65535. In this case, if we display the image loaded in a), all we can see is black. Therefore, we should first scale the image to the type of unsigned int8 (0 to 255).

After acquiring unsigned int8 image volume, it is easily noticed that there exist some small areas where contain black and white parts at the same time. This can make a bad influence on the segmentation result, so naturally, we consider to use median filter to deal with the "salt&pepper" noise. And then, like all other applications, a Gaussian filter is applied to smooth the image for the sake of removing unexpected noise.

Now in order to get a global threshold for the image volume, we can simply create a single image to represent the mean value of all the slices. This can be done by using `OrthoProjection`. There is a problem of this block and we will discuss in the section III.

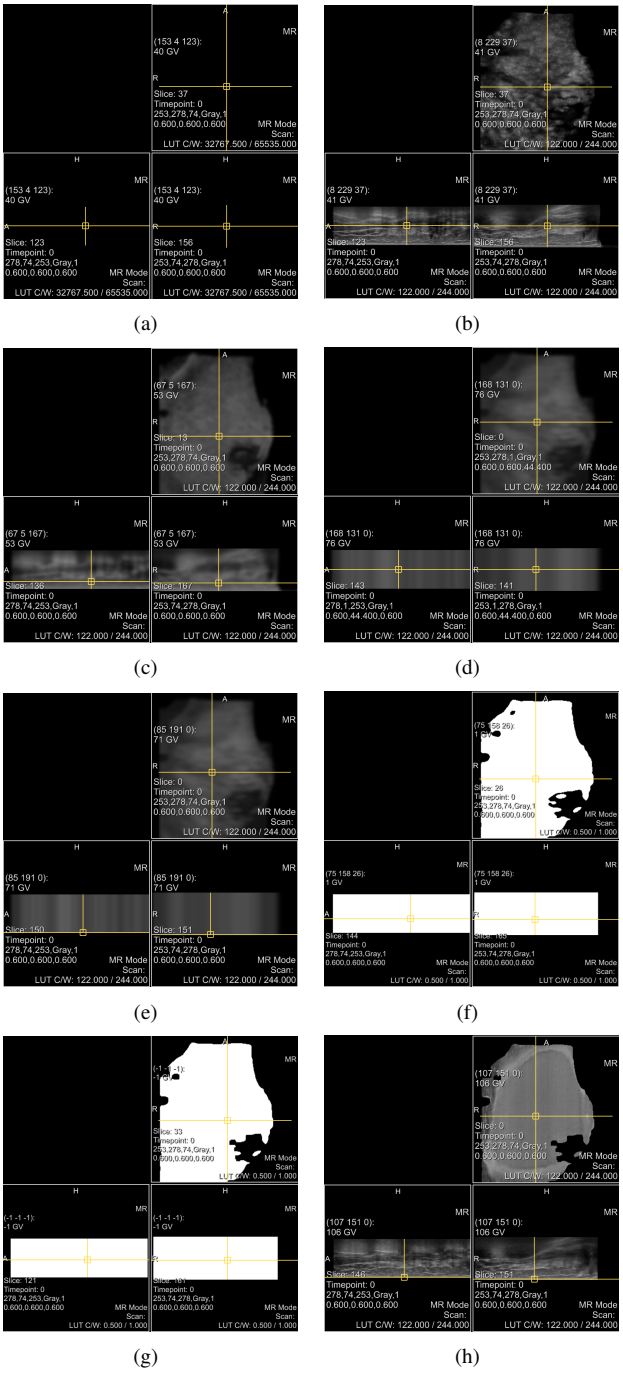

Fig. 1. The whole procedure of breast boundary segmentation

After this, we replicate the mean image back to a volume

having the same dimensionality as the original volume. `Resample3D` block is used. One thing that should be paid attention to is: remember to change the image size in the Panel of `Resample3D` the same as the original image size. Only in this way can we multiply two volumes correctly.

Next step is to find the global threshold for the image volume we acquired from resampling just now. Here the famous Otsu's method is applied and a binary image volume is obtained based on the threshold.

In the Fig. 1(f), there are several small holes and we apply closing operations to each slice of the binary volume so that some holes can be filled.

Finally, we simply multiply the original volume by the binary volume, which is exactly our segmentation result. More segmentation results are shown in the Fig. 2 and Fig. 3.

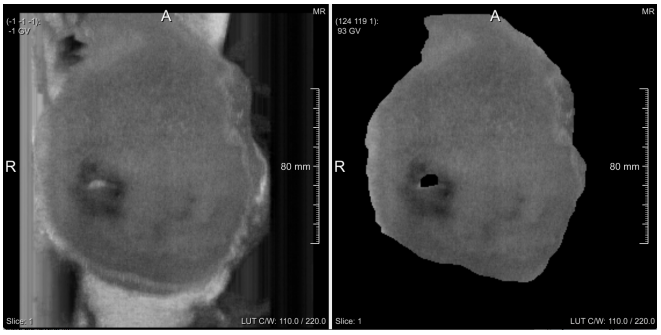

Fig. 2. Illustration for the segmentation (1)

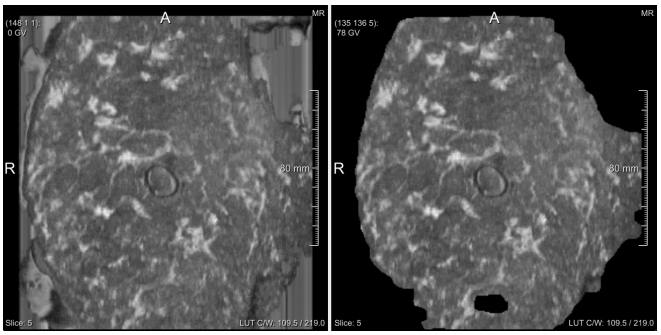

Fig. 3. Illustration for the segmentation (2)

III. Limitation & Problem

A. Limitation

Although we try to use different methods to fill the hole within the map, there are still one or two big holes in the image that can not be removed. The main reason is: we calculate the mean of the image volume , which is not really accurate because some parts within the segmentation area may have really low value, for example the down-right hole in Fig. 1.

The single image with the mean values is used for computing a global threshold of the whole image volume, which is another reason for the problem. If we can acquire a threshold for each slice of the image, the accuracy can be definitely increased much. However this is already out of the requirement of the lab.

B. Encountered Problem

Using `OrthoProjection` is the biggest problem of this lab. As we can see the segmentation result from the Fig. 4, the axial view is ok but the sagittal and coronal views only have very thin regions. They are dramatically suppressed. We found out the reason for this problem after analysation. In the original image volume, the thickness of each slice is 0.6mm. However, after applying `OrthoProjection` to acquire a 2D image with the mean values of the whole volume, the 2D image has the depth of $0.6 \times 74 = 44.4mm$.

We replicate the image and create a 74-slice volume if we use `DimensionSliceClone`. Now the depth becomes $44.4 \times 74 = 3285.6mm$, while the height and width of the volume are both only around $200mm$, which are less than 10% of the depth. So the two views is really thin. In order to solve this problem, we use `Resample3D` to split the 2D mean image to 74 slices, so each slice has a depth of 0.6mm.

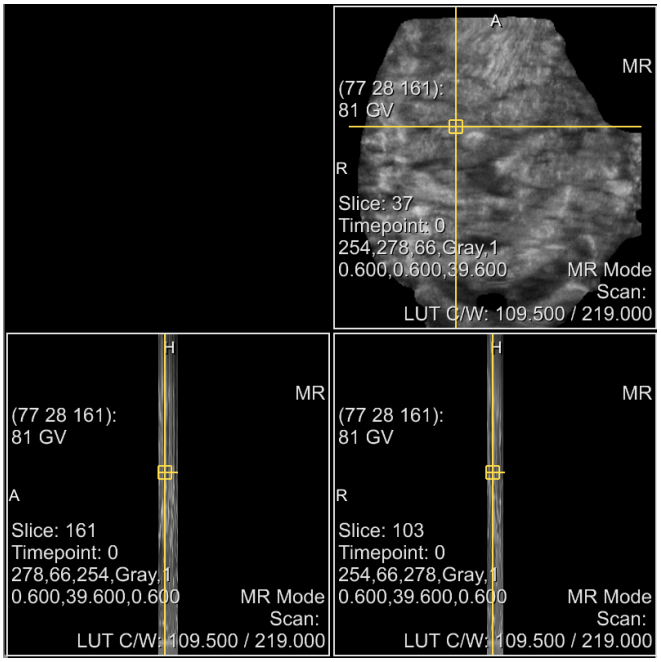

Fig. 4. Illustration for not using `Resample3D`

IV. Conclusions

In this session we mainly took advantage of Mevislab and implemented a breast boundary segmentation system which contains 8 steps in total for the whole process. The system satisfy the "fully automatic" requirement and can be applied to most of breast images.

We observe that even if we have applied different filters and morphological operations, there still exist a few large holes in the segmented area which can not be filled, which increases false negative rate.