An Interactive Segmentation Method for Thermal Breast Images

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GW | SEAS

BACKGROUND

- In its first stage, a cancer promotes an intense process of vascularization at the affected area, increasing blood flow and modifying the local temperature of the body [1]. Previous theoretical and simulation studies in our lab have shown that certain relationships exist between the presence of a tumor and increased localized surface temperature [2, 3].
- Thermography is a noninvasive, non-contact, radiation-free screening procedure in which infrared radiation emitted by the human body can be captured in an image. This makes thermography a promising procedure for detecting suspicious regions in patients of any age, even in the case of dense breasts, where the detection of an abnormality often cannot be accomplished by routine exams.
- There is not much clinical use of thermography, however, because of the current subjective nature of the interpretation of thermograms. Accuracy of diagnosis in objective methods of thermography interpretation depends in part on how well the region of interest is segmented.

In this study a segmentation method facilitated by a graphical user interface (GUI) was developed to automatically extract the region of interest. The GUI allows the user to run the segmentation algorithm and adjust various parameters.

The aim of this study is to help reduce the efforts and inaccuracies of segmenting these regions along with addressing some of the inherent limitations that researchers face when designing automatic segmentation methods, such as lack of clear edges.

DATA/MATERIALS

The set consists of a series of thermal imaging sessions of four women volunteers. All confidential information was anonymized prior to review.

The thermal images were acquired using an infrared camera (Thermal Imaging Systems, Irvine, Calif.: 8-14 μm, 320×240 pixels, 30mK sensitivity).

The software (MathWorks, Inc.) was used to write all programs for the segmentation procedure; functions are listed in parentheses.

METHODS

KEY: Automatic | Interactive

Enter Image

Figure 1

1. Pre- Process: Use Otsu's method to eliminate background background (graythresh) and increase contrast using (imadjust).

Figure 2

2. Apply Filter: Use default Canny Edge detection to generate edges

Figure 3

3. Edge Linking: Connect the broken edges in the image using (imclose)

4. Visual Inspection: If the user identifies any incorrect boundary pixels then proceed on to next step; otherwise move to Step 6.

Figure 4

5. Apply Edge Removal Algorithm: This algorithm removes any small connected edges with fewer than x pixels. Sliders are implemented in the GUI so the user can adjust x.

6. Recheck: Once the Algorithm is applied the user can select "Segment" in the GUI. The GUI will not segment, however, until there are at most four edges in the filter.

7. If there are more than four edges this means that there are edges in addition to the breast and body boundary. The user must go back to re-run the edge removal algorithm in Step 5.

8. Segment: If the plotted edges correspond correctly to the breast boundaries, then the pixel values in the area below the boundary are set to 0.

Figure 5

RESULTS

- This method was used to isolate the breast regions in a series of gray scale thermal images. The results of the segmentation and boundary connection were considered to be successful when visual inspection in figure 4 showed complete isolation of the area underneath the breast.
- As seen in figure 3, results from Canny often yielded many small edges that did not belong to the breast boundaries. Therefore an edge-removing algorithm was developed to remove unnecessary boundaries.
- Figure 4 shows the outcome of the algorithm. Visual inspection also showed success in isolating small edges, yielding only body and breast boundaries.

CONCLUSION

- This study proposes a segmentation method, accessed by a custom GUI, to delineate the regio interest to assess abnormal temperature differe on the breast surface using thermograms.
- Although the program is interactive, it is not sensitive to the user's judgment for the thre As described in Step 6, a recheck process to make sure the result has only four edge eliminates subjectivity of the segmentati
- Our results with a small set of breast th show the potential of the proposed me used for breast analysis.
- Future work will focus on improvin further limiting the search area an with larger datasets.

REFERENCES

[1] J. Head, C. Lipari and R. mammography and breast infrar specificity, false negatives, false po value and negative predictive value Conf., Atlanta, 1999, p. 1116.
[2] L. Jiang, W. Zhan, and M. H. the complex mechanisms behind overview for comprehensive nan 7965, Medical Imaging 2011, 79
[3] L. Jiang, W. Zhan, and M. dynamic thermography of the deformation," Phys. Med. Bio 202