Snakes Versus ConnectPixels:
Segmentation of IR Images for Breast Cancer Detection

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OBJECTIVE

Develop and compare the accuracy of two methods of automated segmentation used to isolate the breast region of the patients' infrared images; increasing the accuracy of automated segmentation is important because it limits the area for tumor search, thereby increasing efficiency and reducing false positives.

INTRODUCTION

The overall study utilizes infrared (IR) imaging of breasts for tumor detection as an adjunct to mammography. This specific study aims to create a method of segmenting the breast regions to allow for an efficient registration and crop of all images with minimal manual input. Increasing the precision and efficiency of segmentation is necessary for cluster analysis.

METHODS AND RESULTS

☐ Thermal images of fifteen patients and thirty-three volunteers were analyzed with MATLAB. This study compares two pixel connection methods, connectPixels and snakes to determine which one more closely approximated the natural outline of the breast.

☐ There were difficulties in segmenting subjects with smaller, circular shaped breasts in previous studies [1]. To remedy this, the visible image was segmented and registered to the IR image, to be compared to the manual truth of the IR image.

☐ Success was calculated for each method with the Jaccard Similarity Index (JSI), using manual segmentation as truth
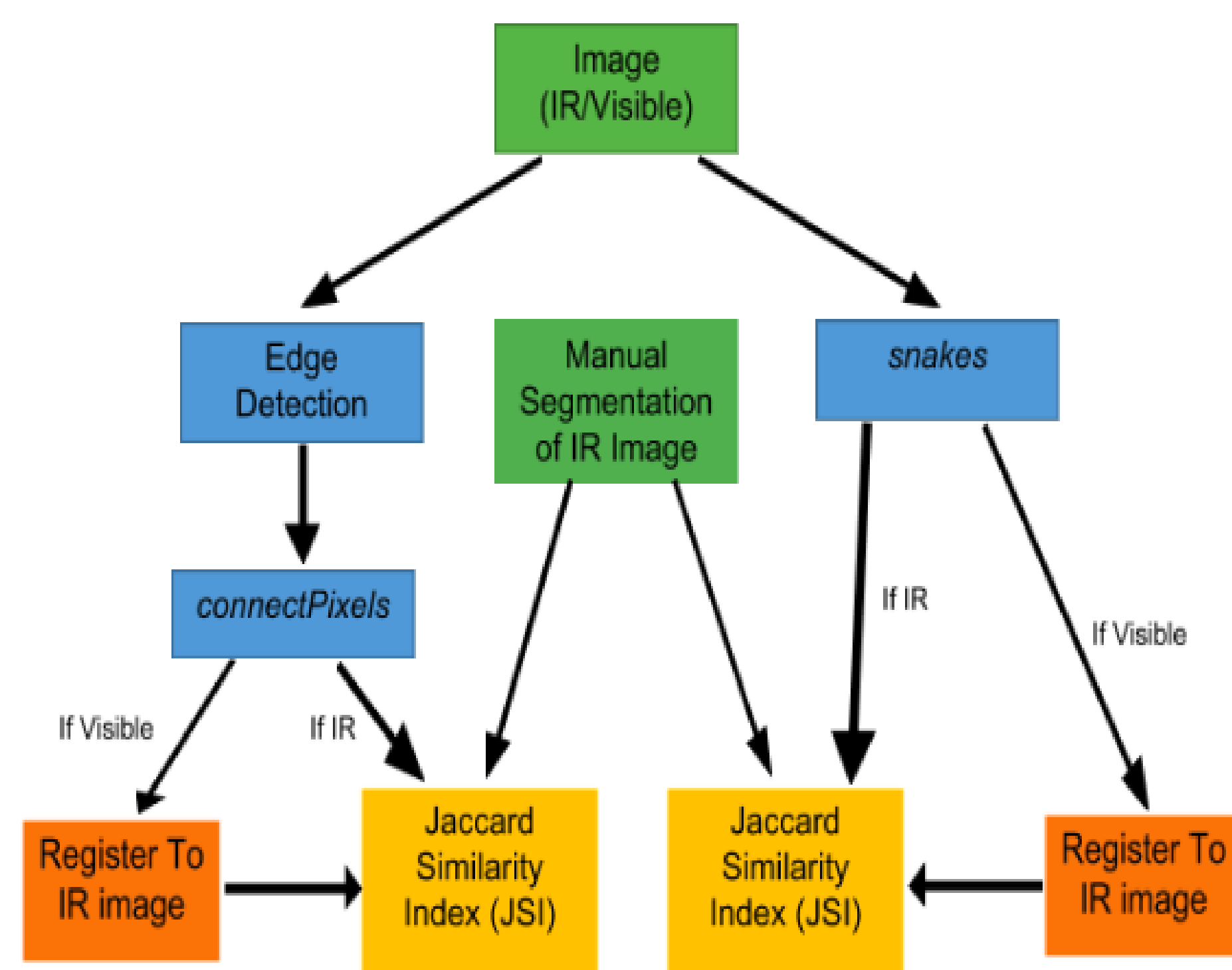

Figure 1. Methods Flowchart

METHODS AND RESULTS (CONT.)

snakes

The snakes algorithm is a common image analysis technique for segmentation [2]. *Snakes* is an active contour that fits a curve based on the internal forces of the curve and the external forces of the image data. These forces either promote or restrain deformation of an energy-minimizing polynomial approximation line towards object contours, picking out an object outline from within the noisy 2D image [3].
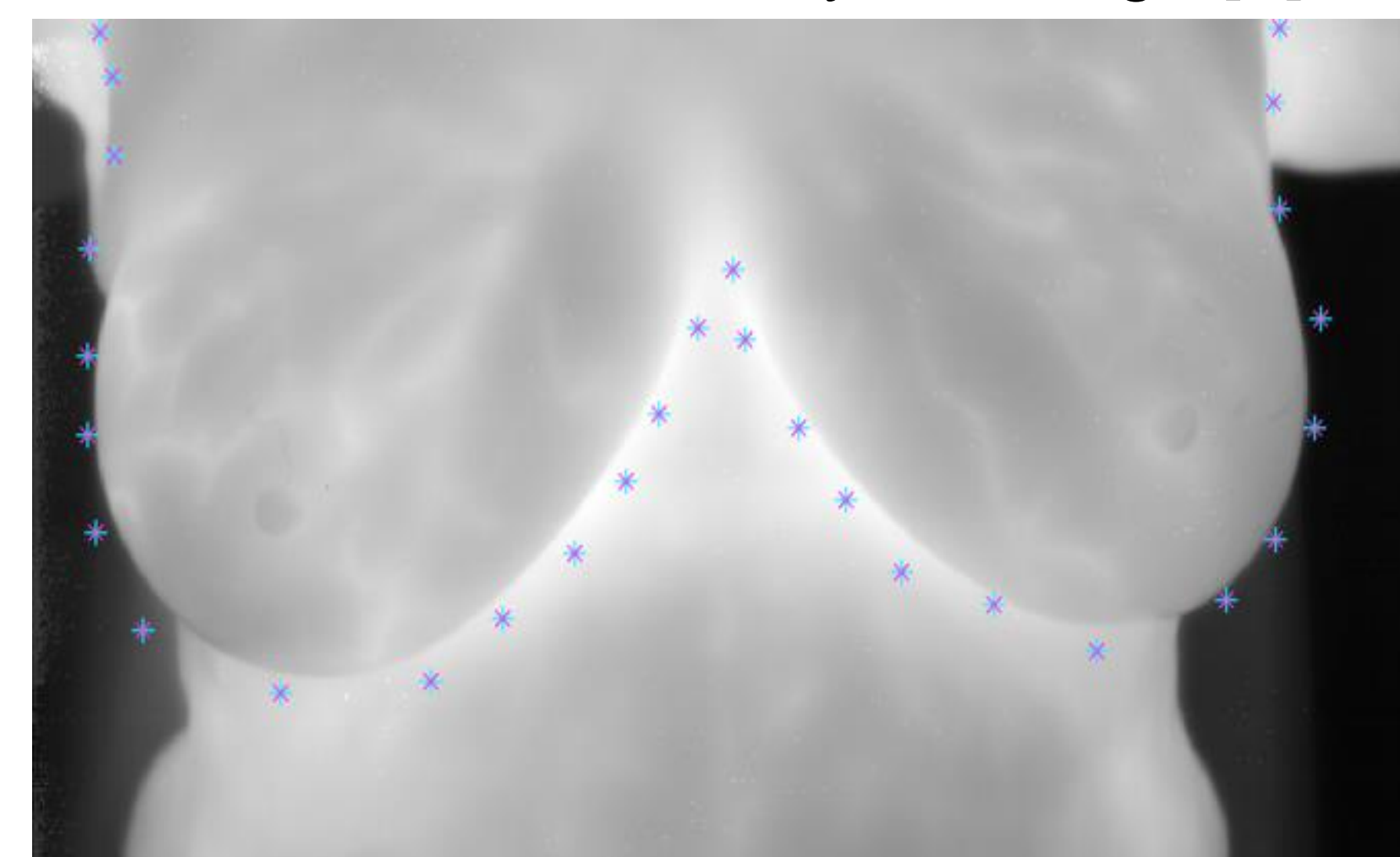

Figure 2. Patient 12's *snake* input. The blue points are manually inputted by clicking on the image. It is optimal to click close to the curve of interest. The best crops found have had 20-30 points.
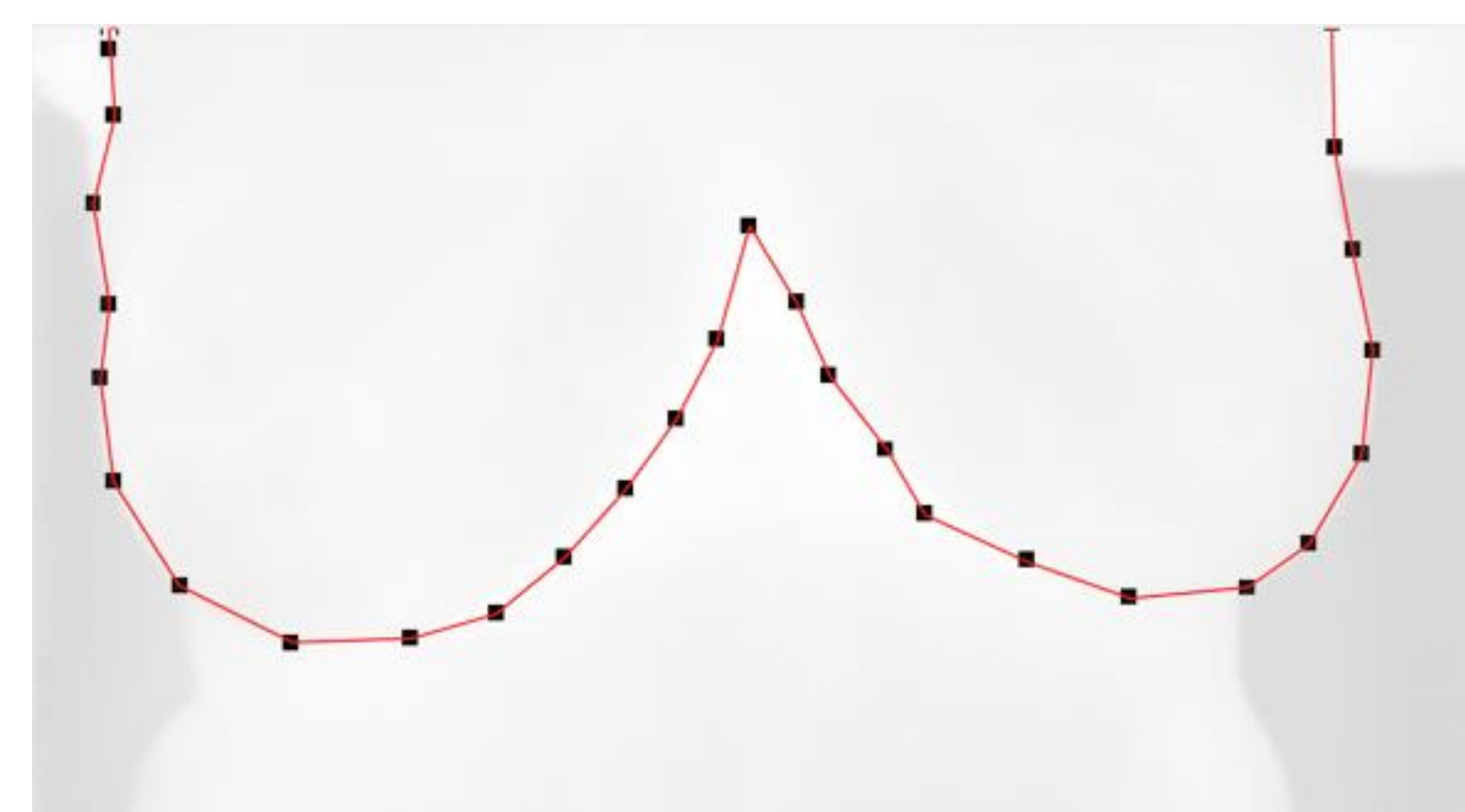

Figure 3. Post *snakes* being run for Patient 12. The red line has connected the resulting points. This red line is what we use as a border to crop the breast region from the rest of the image.
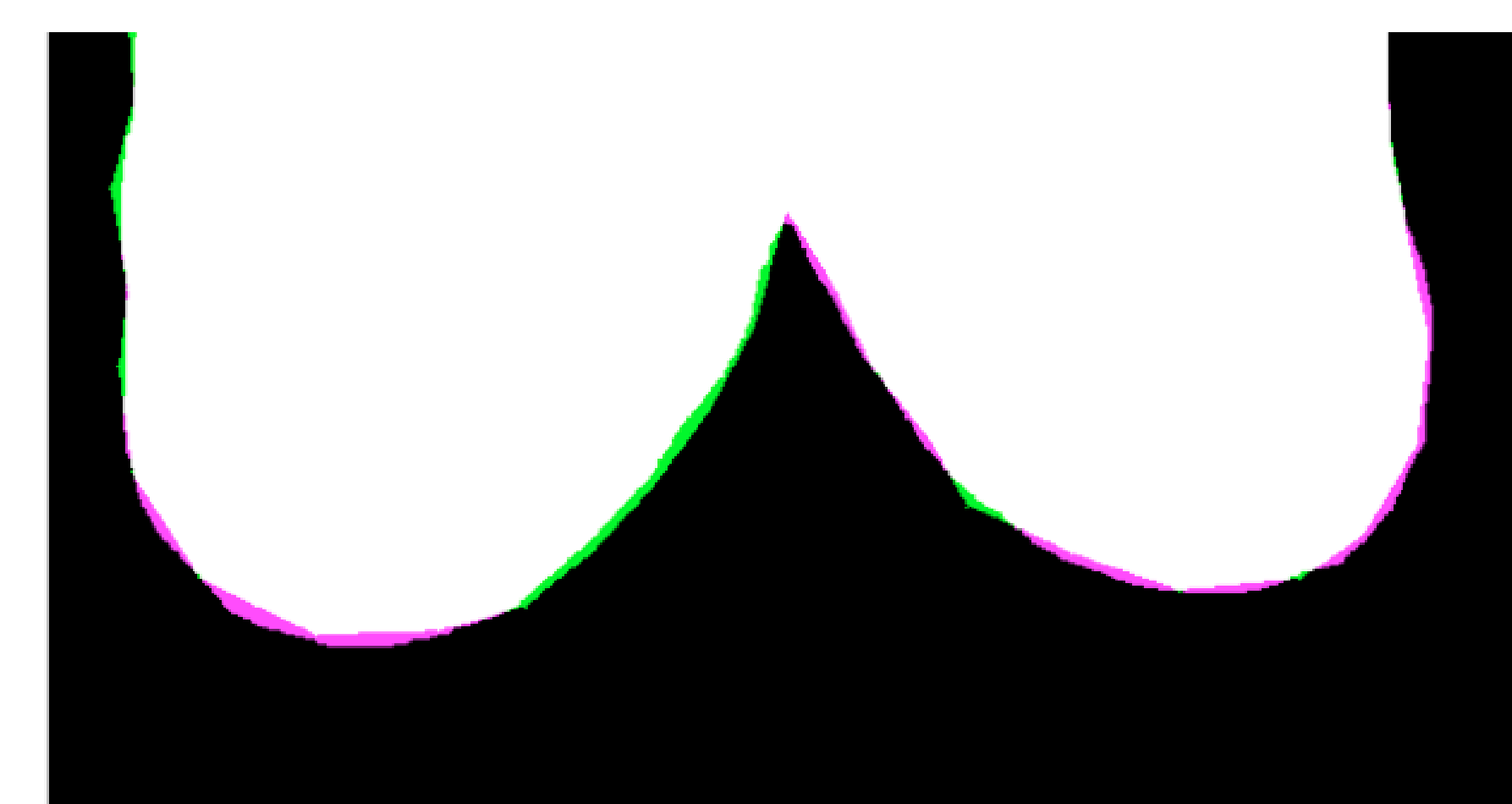

Figure 4. Jaccard Comparison Results for Patient 12's *snakes* and truth image. The magenta and green are the regions that do not match. Magenta is what is present in truth and not *snakes*, green is what is present in *snakes*, not in manual.

connectPixels

A combination of Canny, ellipse, and Laplacian of Gaussian (LoG) edge detections, and detection of the warmest five percent of pixels produced pixels that were weighted using a point system. These output pixels that passed the point system were labeled as edge pixels.
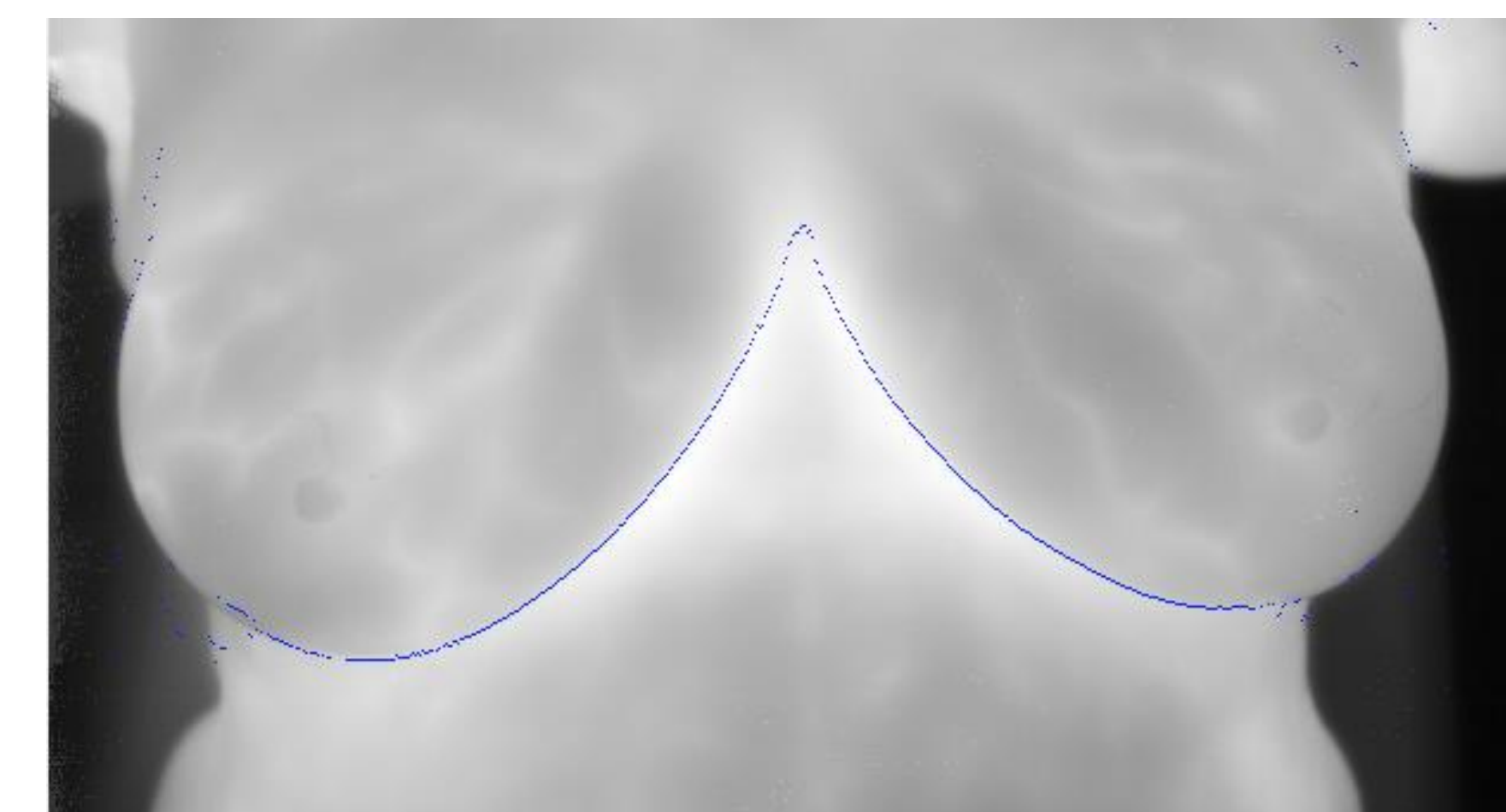

Figure 5. Patient 12's *connectPixels* input. The blue points are edge pixels determined by a combination of edge detection methods.

The connectPixels function connected edge pixels by 1) stepping through each one, 2) determining whether the closest pixel should be above or below it, 3) locating the closest pixel within a specified radius, and 4) connecting the edge pixel to its closest edge pixel by drawing a line between them with the function *linept* [4].
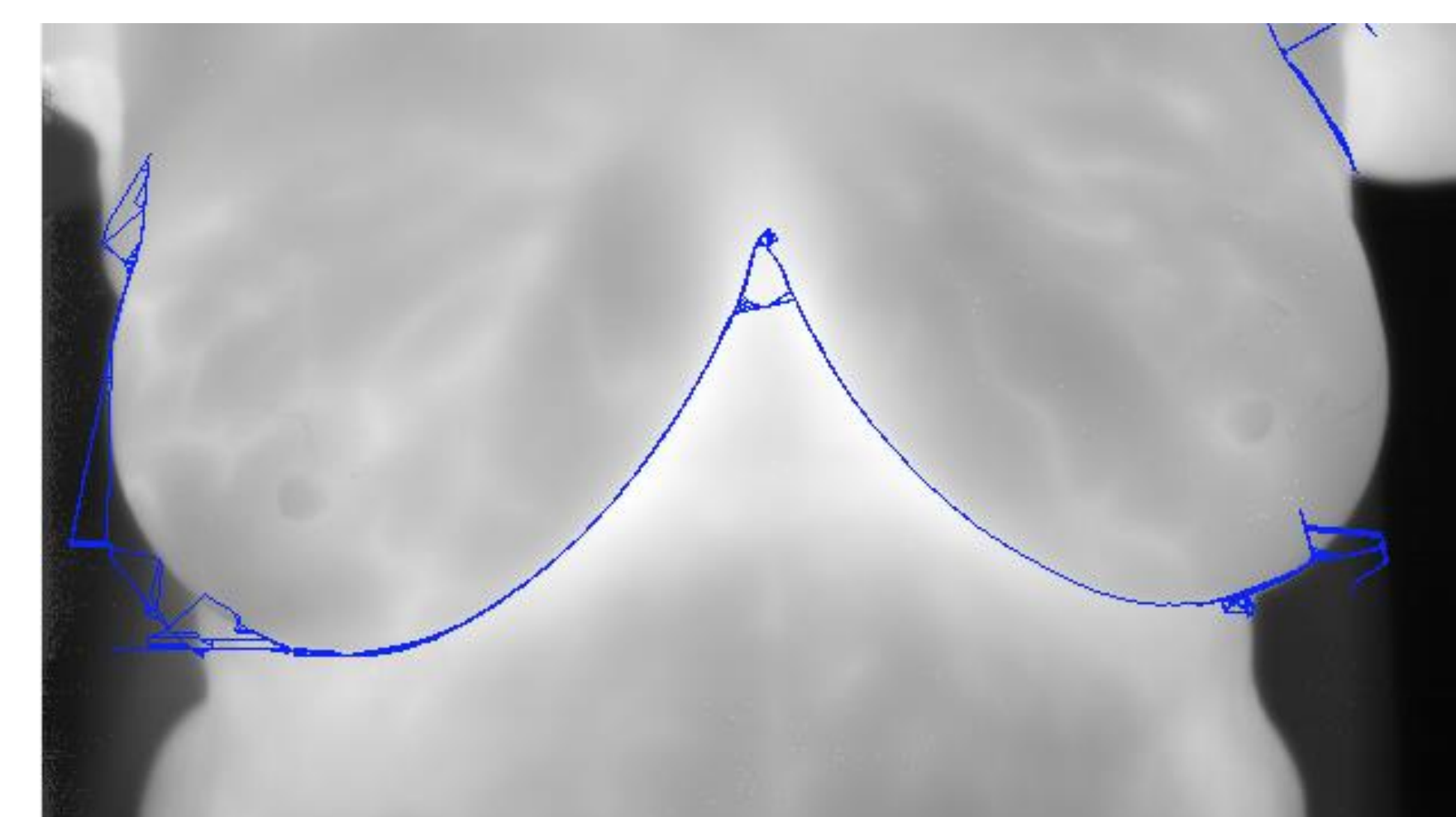

Figure 6. Post *connectPixels* being run for Patient 12. The blue line has connected the input (edge) pixels. This blue line is what we use as a border (along with a user selected topline connection) to crop the breast region from the rest of the image.
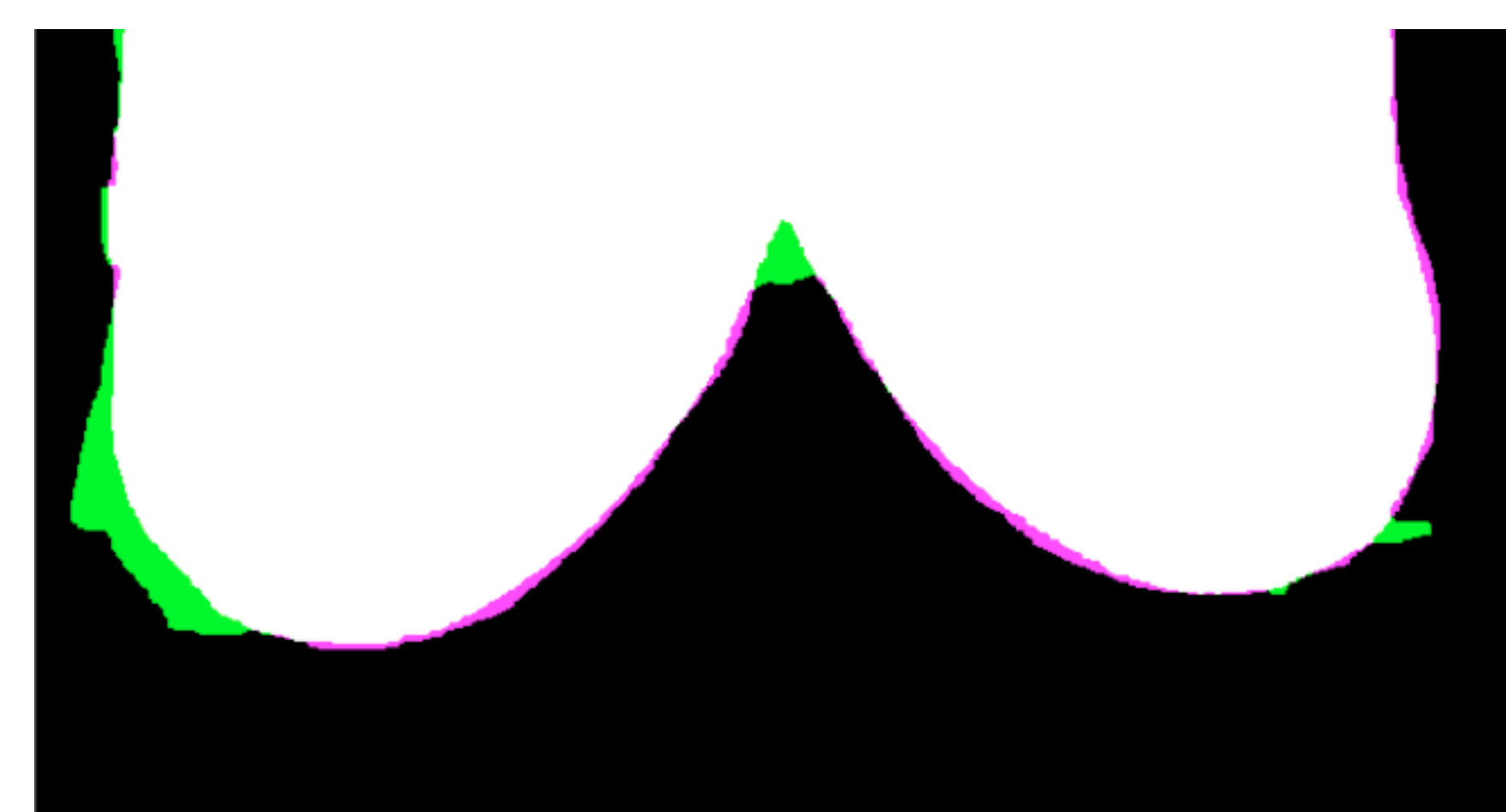

Figure 7. Jaccard Comparison Results for Patient 12's *connectPixels* and truth image. The magenta and green are the regions that do not match. Magenta is what is present in truth and not *connectPixels*, green is what is present in *connectPixels*, not manual.
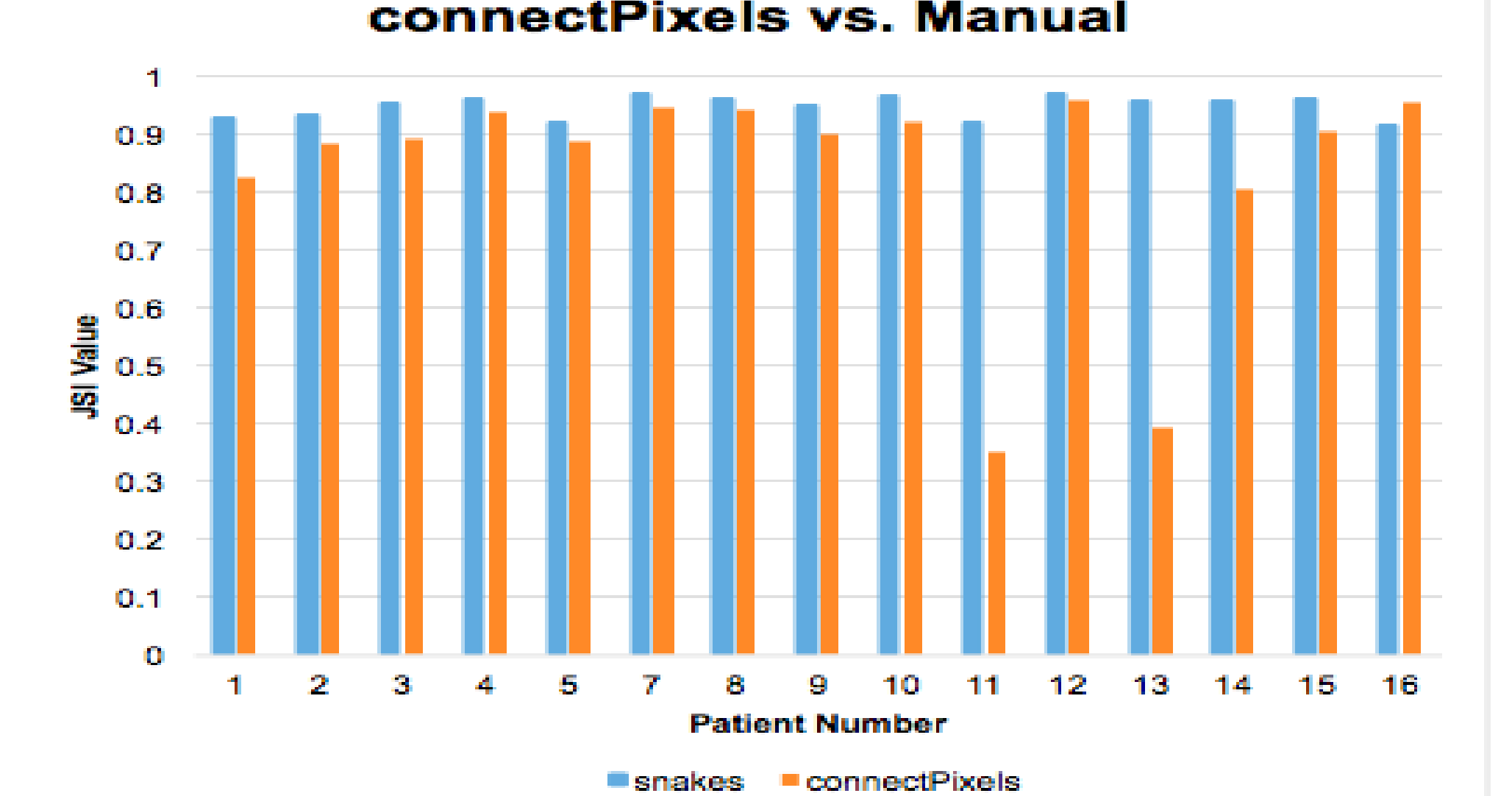
DISCUSSION AND CONCLUSION

Figure 8. JSI Values of IR Segmentation for Each of the 15 Patients.
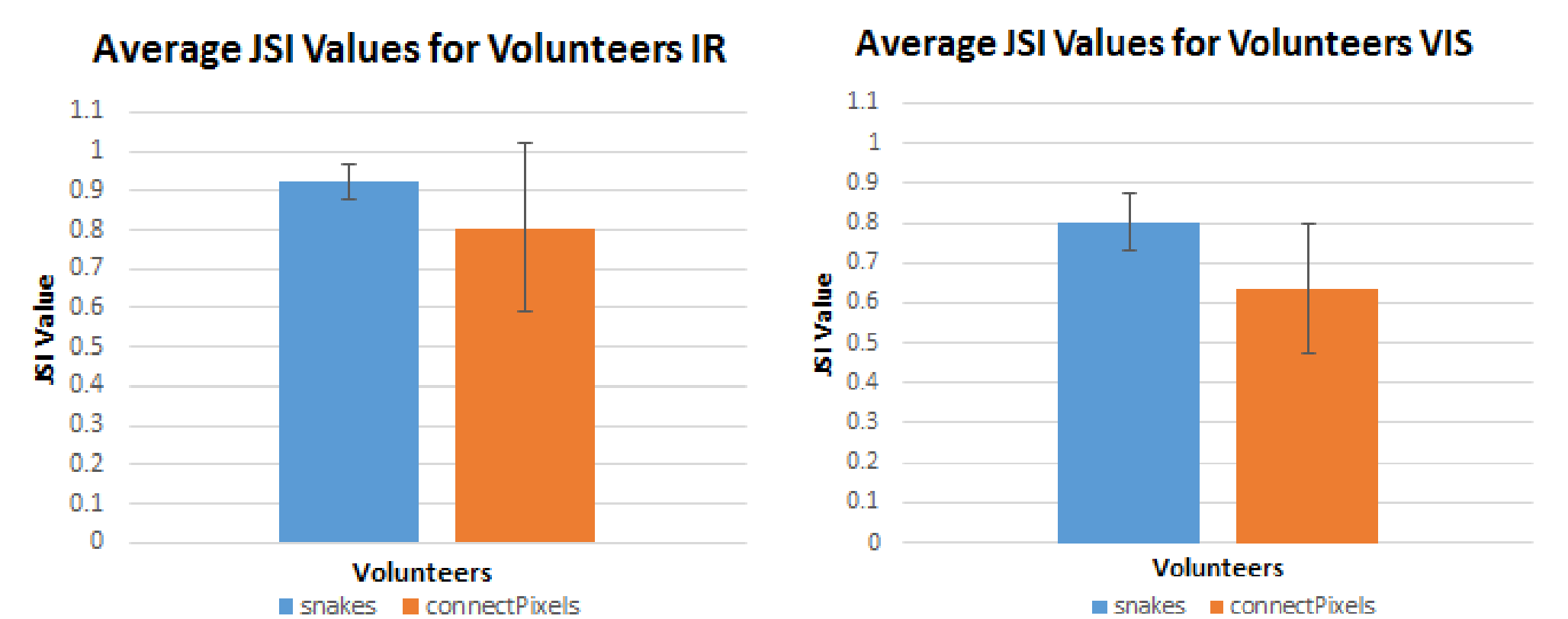

Figure 9. Average JSI Values and Standard Deviations of IR Segmentation for All Volunteers.

Figure 10. Average JSI values and Standard Deviations of VIS Segmentation (IRVT 25 to 28).

☐ For direct segmentation of the IR images, *snakes* was a closer match to truth than *connectPixels*. *connectPixels* required less manual input than *snakes*, but *connectPixels* had difficulty processing images of smaller breasts, and especially volunteer images.

☐ For visible image segmentation, the same trend followed, but the JSI values were lower overall. This could be due to issues with registration between visible and IR images.

FUTURE RESEARCH

Future studies will involve automating segmentation further by reducing manual input. The *connectPixels* method will be developed further to be more accommodating of different breast sizes and ultimately, developed to be a more uniform cropping method. Furthermore, these results rely on the visible images of only four volunteers; using more visible images will increase the significance of the results.

REFERENCES

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