AVPR

Automatic Nipple Detection In
Breast Thermograms

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Introduction

The first AVPR assignment is based on a paper that talks about automatic nipple detection in breast thermograms. This paper purposes a new algorithm to detect nipples in human images. Nipple detection is so important to be used to segment the regions of interest from the whole infrared image.

Therefore, for this assignment, we have to code the proposed nipple detection method using Matlab.

Proposed Method

This paper proposes different steps to achieve the goal explained previously.

Human Body Segmentation

This stage is about human body segmentation given a human image.

First of all, we have to create a human mask image using a threshold. All pixel values are compared with this threshold, depending on whether the value is greater or less than the threshold, a 0 or a 1 will be written in the corresponding position. The output will be a binarized image with the human mask.

Secondly, we have to smooth the image using morphological operations. To do this I used morphological closing with disk-shaping structuring, and morphological dilation with a radius of 3 and 10 respectively. Then, I replaced mask values in the grayscale image with 0.

In third place, I created a new function to determine the nipple candidates by analysing the segmented image. So, I used median filtering with a local neighborhood of 15 and a sensitivity of 0.03. Once we have the convolution of the image, I used the imsubstract() function to subtract the original image from the convolved one. Then, I applied thresholding to the resulting image with 0.03 of sensitivity through imbinarize() function.

So now we have a set of candidate nipples, therefore we have to select the real nipples from this set. To do this, we need to remove all components with less than 20 pixels using bwareaopen function. Then, I calculated all the needed values to select the nipples. For example, I calculated Hup, Hlw, and other values. Also, we have to crop the image using Hup and Hlw values. Therefore, now we removed all possible values that are outside of the interesting regions.

To extract the interesting areas from this image I used bwconncomp() function to find and count the connected components in the binary image. From the returned CC, I extracted the properties of the components (Centroid, Area, and so on).

Now, we have to determine which nipples are from the left and right sides. To do this, I used de X center-line value and two arrays to store the index nipples for each side. So, the rest of the algorithm is very easy: I coded a function to select a nipple from the set of candidates. To select a nipple, we have to get the nipple with maximum roundness. If two nipples have the maximum values for circularity, we must select the one which with a higher area. Finally, I stored the left and the right nipples, and the Hlw values to be used as shifts to plot the nipple marks in the image.

Finally, I calculated the nipple coordinates in the image using the Y coordinate, and the Hlw stored previously. Then, I plotted the nipples on the image using insertMarker function, which takes the image and the coordinates.

Therefore, I coded the algorithm purposed in this paper, to normalize our image, get the nipple candidates, select the real nipples, and plot these.

Results

About the results, my code can detect nipples from clear images. Let's see some examples:

IR_0100

The first example is very clear, the input images are so clear and detection algorithm can identify all nipples in the image.
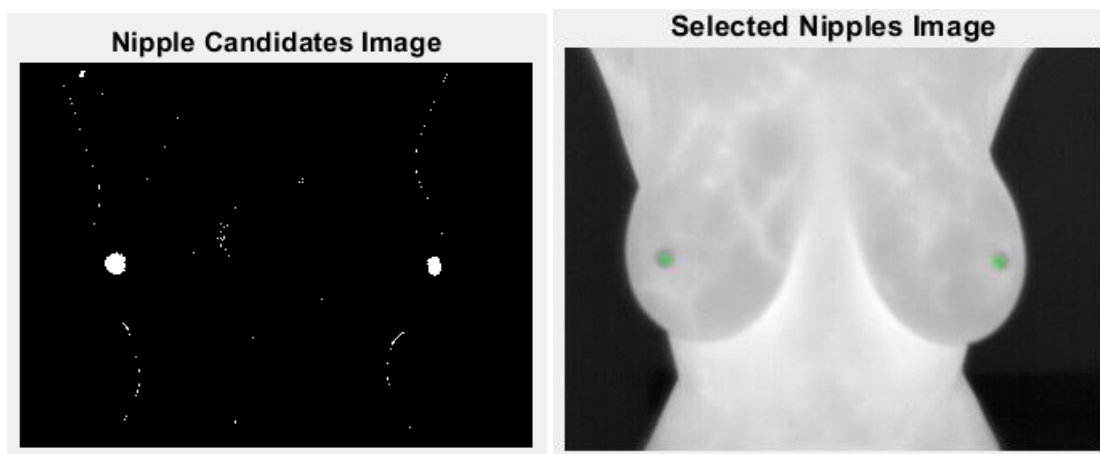

IR_1367

For the second example, as we can see, the final plot is not accurate. So, where is the problem, in the image or in the detection algorithm?

In my opinion, the problem is the image because the nipples are not clear. We can see the human body, but the detection algorithm cannot clearly identify nipple areas with a high number of white pixels with a high roundness value. Therefore, the algorithm is selecting the components with more roundness or area but is not working properly.
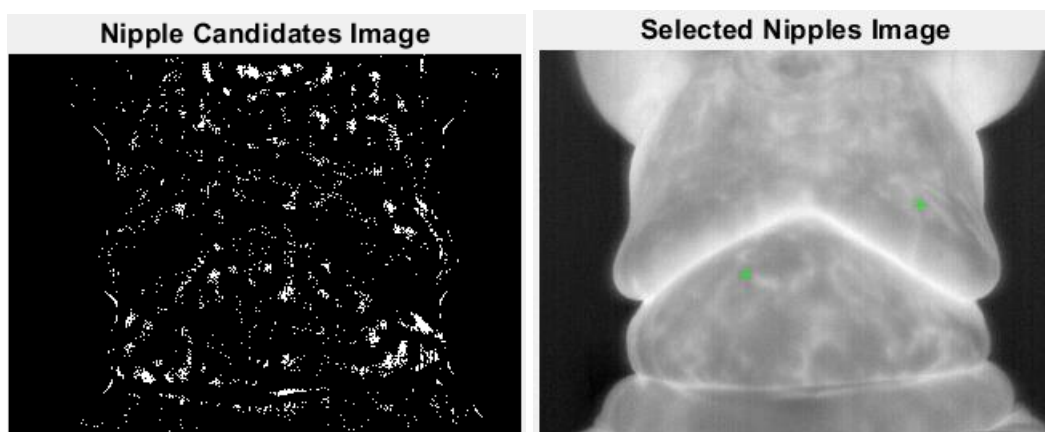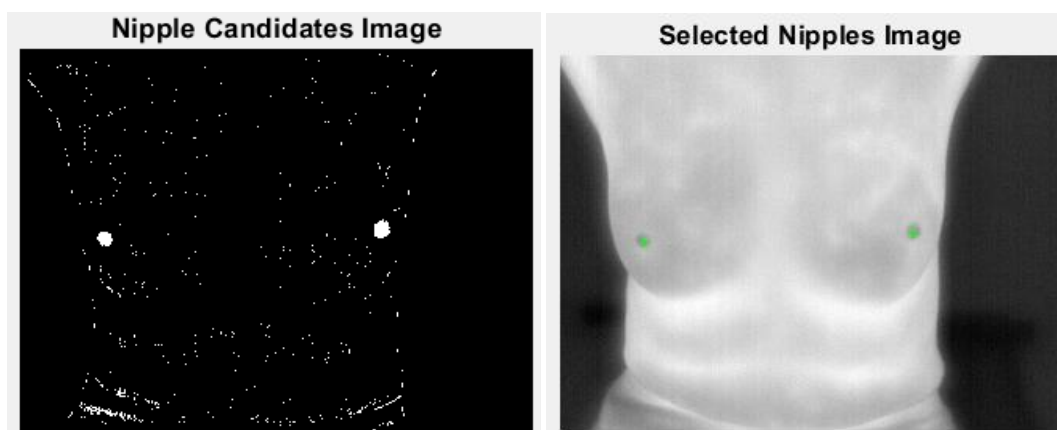
IR_2841

In this example, as we can see, the nipples are very clear in the original image. Therefore, the mask has two roundness areas that correspond to the left and the right nipples.
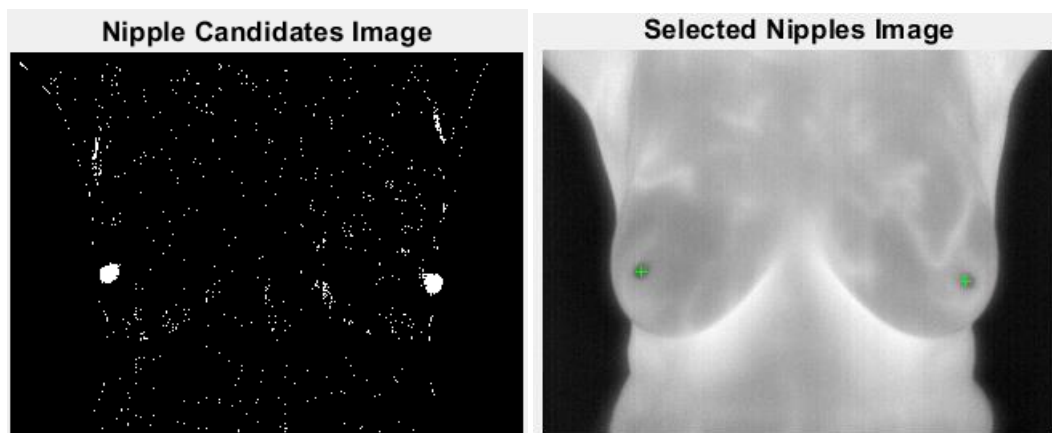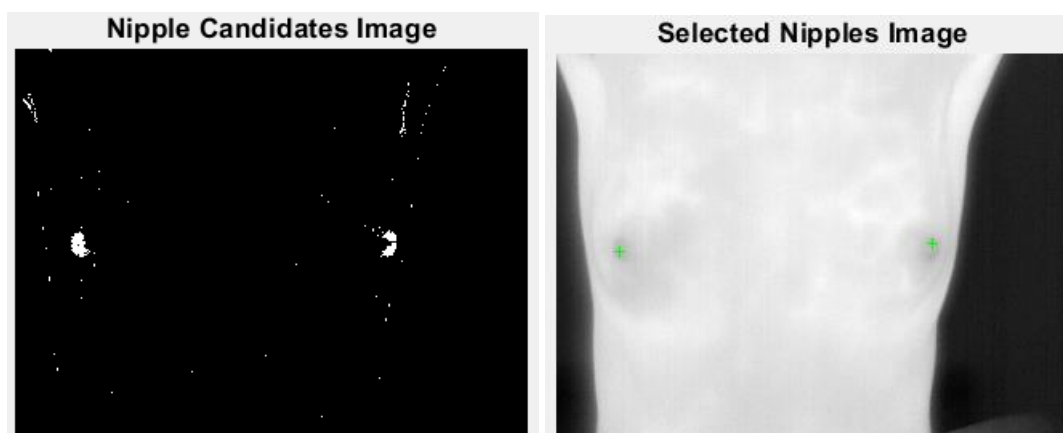

IR_3635

This example is like the previous one. The algorithm is accurate in finding nipples.


IR_3759

Also the results are accurate, and we can identify clearly the human nipples.

IR_4089

Finally, this example is like the second one because the nipples are bigger than in the other cases. Also, with respect to the rest of the image, these kinds of nipples do not contrast as much with the

rest of the body. Also, the areas with more white pixels don't have a high roundness value. For this reason, the right nipple is not selected.
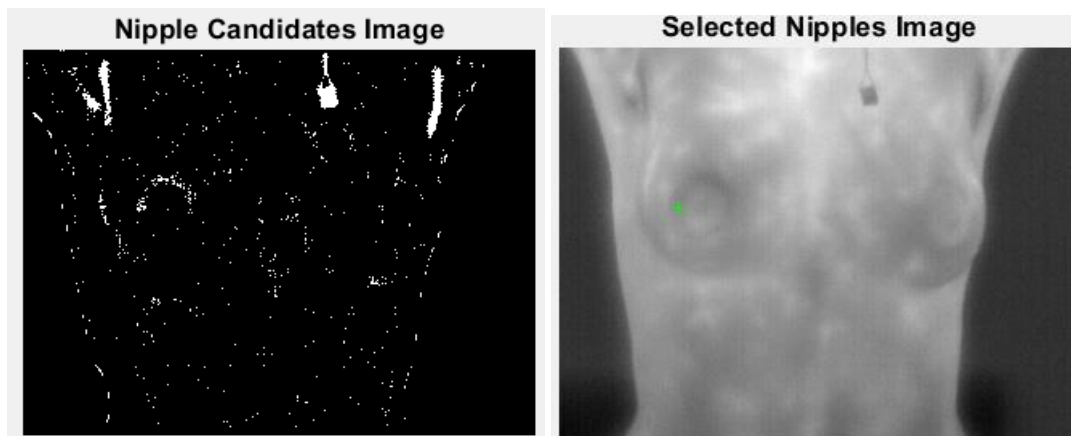
Conclusions

In my opinion, this paper for a master's student is very interesting to understand the logic that is behind this subject. For example, for me is very interesting how to use Matlab tools to filter the interesting information and verify that we found, in this case, a nipple. Also, I think that an assignment is very helpful to learn how to extract the most important information from an image (centroids, area, and so on).