Artificial Vision and Pattern Recognition
First Assignment

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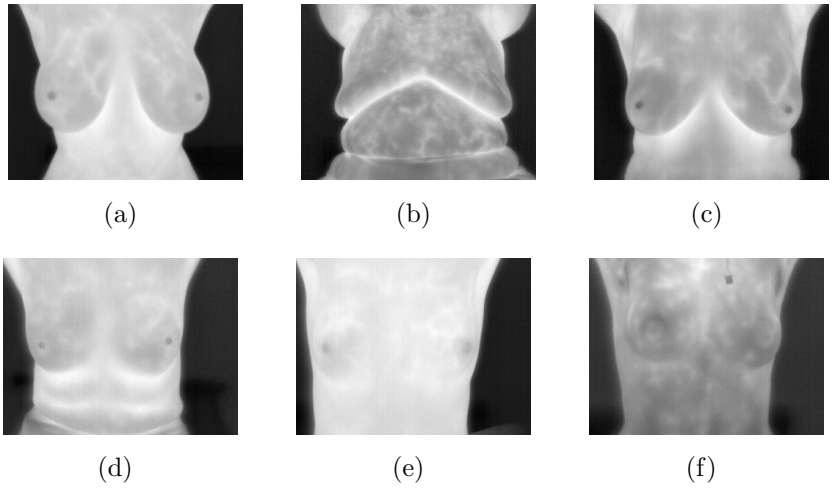
Automatic nipple detection in breast thermograms

The purpose of this task is to implement a Matlab function capable of automatically detecting the nipples in thermograms. The main steps of the proposed method are: segmentation of the human body, determination of candidate nipples using the adaptive threshold and detection of the nipples using a new selection algorithm. The Matlab function receives a thermogram as input and returns the input image including the position of the overlapping nipples. At the end it requires to describe and discuss the results obtained by evaluating the algorithm on a test set of size 6 images:



(a) (b) (c)

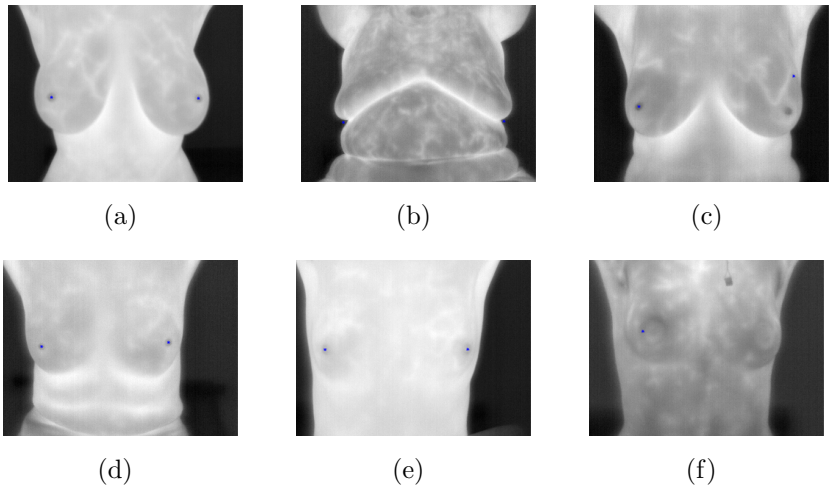
(d) (e) (f)

Figure 1: Test Set

The implemented algorithm is in `nipple_amodio.m`, as required by the assignment, while in this report the results obtained from the processing of the algorithm on the images of the test set have been discussed. Other parameters than those suggested by the paper have been also found which allowed better performance on this test set, but in the end it has been decided to keep the paper parameters. Although the test set is small, it is heterogeneous. In the Fig. 2 the results of the proposed method have been showed with small breasts (Fig. 1(e)), medium breasts (Fig. 1(d,f)) and big breasts (Fig. 1(a,b,c)). We can understand how for some images the detection is

very simple, while for others it is more difficult, even for human eyes. By taking stocks we can confirm that the nipples in Fig. 2(a)), Fig. 2(d) and Fig. 2(e) are correctly detected, while the algorithm is wrong detection in Fig. 2(b), Fig. 2(c) and Fig. 2(f).

Analyzing one by one we can first focus on Fig. 2(b); this image is very particular because it is not understandable where nipples are and if they are in the image. So we could have expected that the algorithm might have some difficulty detecting them. In Fig. 2(f) the algorithm fails to detect the nipples: he detects the left nipple, but is a false positive. In the same way it cannot detect the right nipple; if we analyze the image, we can see how the region of undetected nipple is not clear in the image, so the nipples can't be detected using the proposed method in this case.



(a) (b) (c)

(d) (e) (f)

Figure 2: Test set images processed

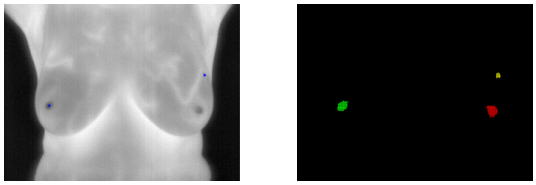
The paper[1], where this algorithm was explained in details, exposes two limitation of the proposed method:

1 It does not work in thermograms in which nipples do not appear or are not clearly visible.

2 It fails to detect nipples in thermograms that contain fuzzy regions, and in which even the human eye would have trouble detecting them.

[1]M. Abdel-Nasser, A. Saleh, A. Moreno, D. Puig, *Automatic nipple detection in breast thermograms*, 2016.

The last misrecognition is in Fig. 2(c); the method detects the left nipple well, while it misses the recognition for the right nipple producing a false positive.



(a) (b)

Figure 3: Regions of Fig 1(c) having a number of pixels greater than N_p

Fig. 3(b) shows the detected region of Fig. 1(c) which have a number of pixels greater than N_p. We can see that the region containing the right nipple is correctly detected (red region) but is not chosen by the nipple selection algorithm. This is because the nipple selection algorithm labels the region that has the maximum roundness as a nipple. In this case the region that doesn't contain the nipple (yellow region) even if smaller then the correct one has a better value of roundness. In fact, the yellow region has a roundness value of 0.77 while the red region 0.57.