Temporal Mass Detection

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Abstract. We present a method to prompt a clinician to "suspicious" dense regions in temporal mammogram sequences. The particular context that we envisage is mammogram screening, when the clinician compares the most recent mammogram to previous ones in order to detect significant changes. The method uses anisotropic filtering as a pre-processing step in order to significantly reduce the number of candidate masses, while preserving the important anatomical information about each mass. The method has already been tested on 15 temporal pairs, where pathology has been diagnosed in the most recent image.

1 Method

The method we propose comprises two steps that pre-process the original mammogram prior to the detection of dense regions: mammogram registration and anisotropic diffusion of the registered mammograms. The basic assumption in our work is that masses appear as regions of slightly enhanced brightness. First, the temporal pair is registered using a mammogram registration method developed in our laboratory [2]. Briefly, it is a three-stage process: (i) the images are aligned based on their boundaries using thin-plate spline interpolation; (ii) internal regions of dense tissue are located using a wavelet-based segmentation algorithm and these refine the registration; (iii) a regulariser is used to account for possible inaccuracies in the selection of the internal landmarks. In this work, registration aims to aid mass detection by comparing "suspicious" regions in the registered mammogram sequence, where false positives can be reduced by visually inspecting the correspondence of "temporal prompts". In order to detect only the most important features of the mammogram, the images are processed using an adaptive anisotropic diffusion-based filter, which enhances the suspicious features in mammograms [1]. The parameters of the filter are computed from a statistical analysis of the image gradient and the mammogram is anisotropically blurred. We find that a large number of suspicious areas become insignificant for subsequent texture classification.

Finally, a texture-based classifier segments the image in different tissue types and the "denser" class is used to automatically prompt to "suspicious" regions. Currently, we detect 4 classes corresponding to: (A) very dense tissue (pectoral muscle and some regions of breast parenchyma); (B) dense tissue, includes all the remaining parts of the dense parenchymal cone (fibrotic stromal tissue and glandular tissue); (C) fatty tissue, represents the fatty background of the mammogram (Wolfe's "normal" involuted breast patterns [4]); (D) fatty breast edge, a homogenous, low-intensity region near the breast edge. A candidate mass is expected to appear either as a “very dense” or “dense” tissue region according to the above classification depending on the presence of the pectoral muscle and on the local density variations. Density variations around an iso-dense contour in the denser classes indicate the presence of abnormalities, namely tumours. These classes are shown in more detail in the results session.

2 Results

Figures 1 and 2 show typical results on both the original and the diffused mammogram pair. Diffusion significantly reduces the very dense regions Where Figure 1 prompts numerous density variations in the image, Figure 2 shows more homogenous regions and reduces dramatically the number of candidate tumours. Table 1 shows preliminary results in mass detection (true positives and false positives for the “suspicious” regions detected) in 15 temporal pairs. We first show the improvement in detection by including anisotropic diffusion as a pre-processing step. In addition the same Table shows the potential improvement in mass detection by visually inspecting the generated prompts in the mammogram sequence (a prompt in the current mammogram is classified as a mass if there is no similar region in the previous one). However, this further improvement is based only on the visual inspection of temporal “prompts”. We aim to incorporate this automatic comparison as an automatic step in future work.

Table 1. True positives and false positives in 15 pairs of mammograms (a mass has previously been diagnosed in each pair).

Temporal comparison of “prompts” (visual)	Anisotropic diffusion pre-processing	True positives	False positives
No	No	15	59
No	Yes	15	13
Yes	No	15	17
Yes	Yes	15	6

3 Conclusion

Anisotropic diffusion can reduce significantly the number of FPs in mass detection based on registered temporal mammogram. Visual inspection of prompts in mammogram sequences (Table 1) indicates that a further improvement can be achieved. Future work will concentrate in developing an automatic method that would enable the temporal comparison of prompts detected in any mammogram of a particular registered patient-sequence.

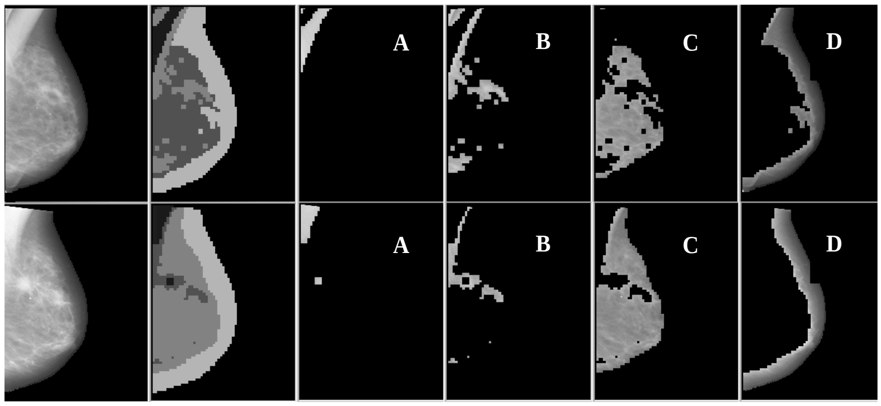
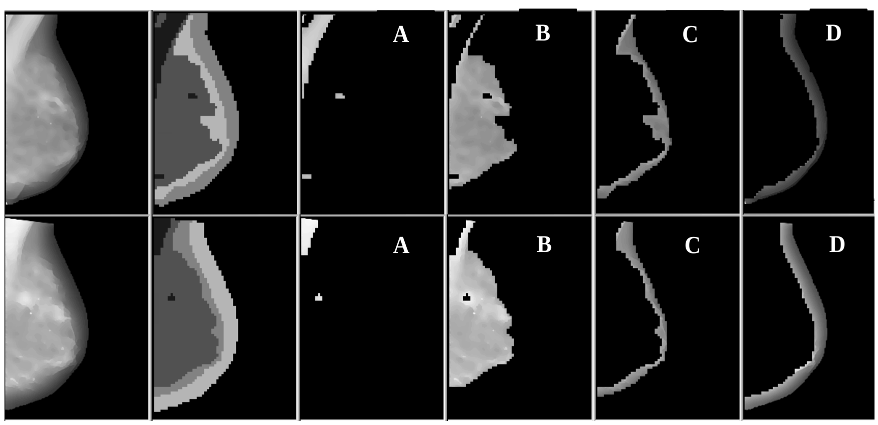


Fig. 1. and 2. Texture classification of the registered mammogram pairs into the classes A, B, C, D. The above set of images show the results before the anisotropic filtering, while the next set of images show the same but after diffusion. The number of candidate masses is reduced.



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