Computer-aided Detection of Spiculated Masses

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Background

•Spiculated masses are characterized by a pattern of radiating lines (spicules) from a central mass region on mammography (Fig. 1)

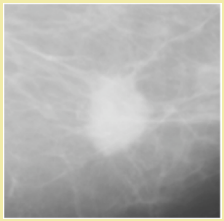

Fig. 1: Example spiculated mass

•Present day computer-aided detection (CADe) systems for mammography are dramatically better in detecting non spiculated lesions than spiculated lesions

•We have developed a model-based algorithm for the detection of spiculated masses whose performance has been previously reported on a limited dataset of mammograms comprised of 50 lesions and 50 normal images

•The objective of this study was to understand the performance of the algorithm when the size of the evaluation dataset was doubled

Materials and Methods

Dataset

•The dataset for this study comprised of 100 spiculated masses and 99 normal images downloaded from the digital database for screening mammography

Overview of the Model-based Detection Algorithm

•Multistage algorithm (Fig. 2)

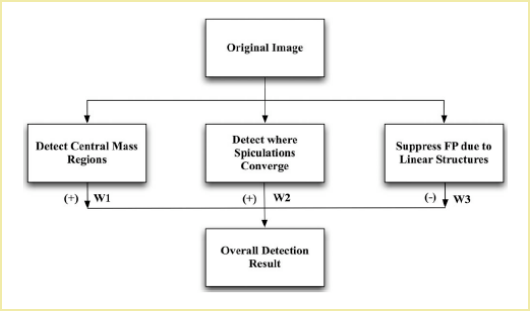

Fig. 2: Detection algorithm

•A filterbank of Gaussian filters was used to detect the central mass region

•The core component of our algorithm is a pair of quadrature filters (f_c and f_s) termed Spiculated Lesion Filters (SLFs) that are designed to explicitly MATCH the convergence of spicules (Fig. 3) and are parameterized using a statistical model of spiculated mass properties

$$f_c(r,\theta;r_0,\sigma,w) = g(r;r_0,\sigma)\cos(w\theta) \qquad f_s(r,\theta;r_0,\sigma,w) = g(r;r_0,\sigma)\sin(w\theta)$$

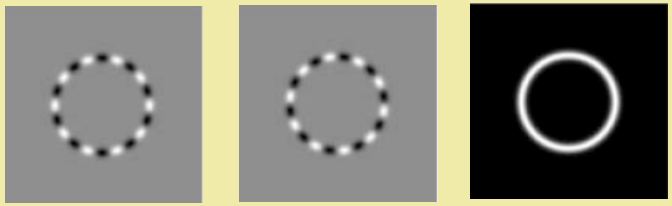

Fig. 3: Cosine SLF (Left), sine SLF (center) and the quadrature envelope (right)

•By nesting multiple SLFs, a composite SLF can be created to MATCH a spiculated mass of a given radius, average spicule length, and spiculation frequency (Fig .4)

• A filterbank of composite SLFs was deployed on an image to detect a spiculated mass

•A filterbank of oriented difference of Gaussian filters was used to suppress the false positive detections due to other linear structures

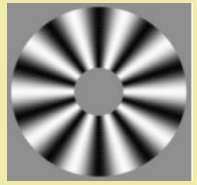

Fig. 4: Example of composite SLF

Results

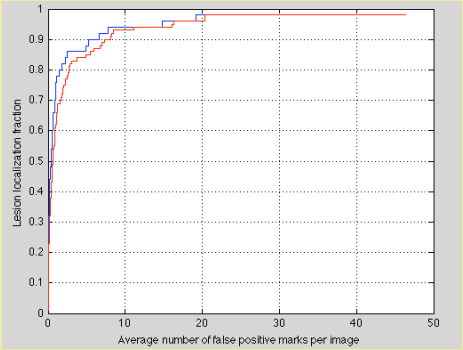

Fig. 5: FROC curves, Blue- 50 lesions and 50 normals, Red – 100 lesions and 99 normals

Conclusion and Future Work

•Doubling the size of the image dataset did not impact detection performance significantly

•Evaluation pending on digital mammograms