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METHOD AND APPARATUS TO DETECT THE MICROCALCIFICATIONS IN X-RAY IMAGES USING NONLINEAR ENERGY OPERATOR

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ABSTRACT
A method and system to detect the microcalcifications (Me) in different type of images viz. X-ray images/ mammograms/computer tomography with varied densities using nonlinear energy operator (NEO) is disclosed to favor precise detection of early breast cancer. Such Microcalcifications are associated with both high intensity and high frequency content. The same NEO output is useful to detect and remove the irrelevant curvilinear structures(CLS) thereby helps in reducing the false alarms in microcalcification detection technique. The is effective on different dataset (scanned film, mammograms with large spatial resolution such as CR and DR) of varied breast composition (viz. dense, fatty glandular, fatty), demonstrated quantitatively by Free-response receiver operating characteristic (FROe). Importantly the method and apparatus of the invention can be used in conjunction with machine learning techniques viz. SVM to favour incipient or small microcalcifications and enabling early detection of breast cancer, thus benefiting radiologists in confirming detection of micro-calcifications in X-rays images/mammograms and reducing death rates.

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CLAIM 1

A method to detect the microcalcifications (MC) in images or mammograms comprising the steps of a preprocessing step comprising
(i) eliminating all extraneous/non-breast artifacts including human introduced labels, radiopaque artifacts and
down sampling the image/mammograms to reduce computational complexity;
a microcalcification segmentation step involving Nonlinear Energy Operator (NEO) based microcalcification segmentation comprising:
(a) generating a smoothed Nonlinear Energy Operator (SNEO) for enhancing microcalcification spikes; and
(b) selecting an optimal threshold selection for detecting suspicious regionscontaining microcalcifications; and

a false positive reduction step comprising removal of curvilinear structure (CLS) texture appearances of image or mammogram by reusing said NEO output to enhance computational speed and the quality of microcalcifications (MC) detection, wherein said false positive reduction step comprises introducing a parameter to detect CLS elements,
given by:

Area of individual element in reduced threshold
-_____
Area of a individual element in full threshold

involving the same said SNEO in the microcalcification segmentation step by reducing average threshold T y which is average of local optimal threshold corresponding to each of the SNEO/NEO operated direction output to p% of the average threshold (where p<100), calculating the of each element, and if the $ is lower than certain threshold (say Ty), object is likely to be calcification as its compactness is high and elements having higher are treated as the CLS elements and thus discarded.