Breast imaging

Mammographic image processing using wavelet processing techniques

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An outline is provided of a method for enhancing the detection of masses in mammograms that is based on the wavelet transform. Improvements in mass visibility in processed mammograms were evaluated to assess the potential of this approach for image enhancement. In this initial study, obviously visualized masses were chosen to evaluate the potential of improving conspicuity of masses in breasts with different density characteristics.

Wavelet transforms

In the fields of image processing and computer vision, transforms such as the windowed Fourier transforms have been used. These methods decompose a signal onto a set of frequency intervals of constant size. Specific applications include image compression and image-texture analysis. Because the spatial and frequency resolutions of these transforms are constant, the information provided by such decompositions is not localized in the spatial domain.

A wavelet transform is a decomposition of an image onto a family of functions called a wavelet family. In comparison with a windowed Fourier transform, which has a fixed resolution in the spatial and frequency domain, the resolution of a wavelet transform varies with a scale parameter, decomposing an image into a set of frequency channels of constant bandwidth on a logarithmic scale. This variation of resolution enables a wavelet transform to "zoom" into the irregularities of an image and characterize them locally.

Computing wavelet transforms requires the generation of the inner-product of a signal with an analyzing function (wavelet). This reflects the character of signal within the time-frequency region where the wavelet is localized. If the wavelet is spatially localized, then two-dimensional features, such as shape and orientation, are preserved in the transform space and may characterize a feature through scale space.

Adaptive contrast enhancement was achieved by decomposing an image into a multiresolution hierarchy of
localized information at different spatial frequencies. Mammographic feature enhancement was performed by the application of a gain factor within selected levels of a multiresolution representation. This method is thus expected to emphasize significant features in mammography and to improve the visualization of breast pathology.

Figure 1 shows a cranio caudal view of an unprocessed mammogram with a small mass (arrow) in the medial aspect of the left breast. Figure 2 shows coefficients of a wavelet transform for the same mammogram at four levels demonstrating how the mass features are preserved through scale space. Level one of scale space corresponds to small features, whereas level four corresponds to coarser features. Figure 3 shows the corresponding two-dimensional wavelet maxima coefficients as binary edges. These maxima alone would