Mass Detection Project - Articles

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### A New Local Adaptive Mass Detection Algorithm in Mammograms

* Binary search algorithm
* Uses INBREAST database
* Each image is divided into equal non-overlapping cells (a grid)
* In each cell of the grid, the pixel with the maximum gray level is gound - location of the maximum pixel is shown as index and its value is named m
* First, last: bounds of the range which is being explored and TH is the proper threshold
* First iteration: TH is assigned with the middle value of the range [0;m] and then the threshold is applied to the whole mammogram
* Circularity measure is extracted from the region that contains index (index is the location of the maximum value): Circularity = P²/4piA
  + P: circunference of the region
  + A: area
  + Maximum circulatiry is 1
  + The less circular the region, the bigger the circularity value will be
  + If the area or the circularity of that region exceeds the corresponding upper limit (Area max; Circ max), then we should search within the upper half of the previous range ([TH; Last])

### A novel computer aided breast mass detection scheme based on morphological enhancement and SLIC superpixel segmentation

* Five major components
* Preprocessing: morphological enhancement (enhances mass-like patterns while removing unrelated background clutters)
* Segmentation: SLIC method
* Pre-screening of suspicious regions using rule-based classification that eliminates regions unlikely to represent masses
* Potential lesion contour refinement (based on distance regularized level set evolution)
* FP reduction based on feature extraction

### A review of automatic mass detection and segmentation in mammographic images - Girona

* Mass detection - single view - unsupervised methods
  + Region-based methods: divide the image into homogeneous and spatially connected regions. Rely on the principle of homogeinety (there has to be at least one feature that remains uniform for all pixels within a region)
    - Region growing: propagation of an initial seed point according to a specific homogeinity criterion, iteratively increasing the size of the region. Aim to extract potential lesion from its background
    - Watershed methods: mathematical morphological approach. Segments the regions into catchment basins (low points in intensity). If water falls into these basins, the level in each basin rises until it is shared with its neighbouring basin.
    - Split and merge methods: recursively splitting the image until all regions satisfy a homogeneity criterion. In an accompanying step, all adjacent regions satisfying a second homogeneity criterion are merged
  + Contour-based methods: rely on the boundaries of regions
    - Difficult to extract boundary between masses and normal tissue
    - Hough transform used to detect circumscribed lesions
  + Clustering methods: group together pixels having the same properties and might result in non-connected regions
    - Hierarchical methods: produces a nested series of partitions; computationally consuming
    - Partitional methods: produces only a single partition. Needs to know, a priori, the number of regions that are in the image; they do not use the spatial information inherent to the image
      * k-means algorithm
* Mass detection - single view - supervised methods
  + Model-based methods: rely on prior knowledge about the object and background regions to be segmented. Prior knowledge is used to determine if specific regions are present within an image or not
    - Include a training stage to learn the specific objects to be detected
      * Mammograms containing a mass: system learns the probable location and the variation in shape and size
      * Mammograms not containing a mass: system learns features of normality
    - Pattern matching: normalized cross-correlation distance (affected by large variation in the shapes of masses); mutual information
      * Chang (5 rules): selected regions should contain 1) a global maximum in a Gaussian smoothed image; 2) a local maximum in the original image; 3) a local maximum in the image coming from the subtraction of two smoothed images (one using a Gaussian filter and other using box filter) and either 4) a small suspicious region of low contrast or 5) a small suspicious region of high contrast
    - Common-approach: extract gradient information from the mamogram and subsequently use this information for training a classifier
      * Detect spicules using second-order Gaussian derivatives operators
      * Decision-trees
      * Markov random field
      * Wavelets

### \*An Efficient Approach for Automated Mass Segmentation and Classification in Mammograms

* First extract the region of interests (ROIs) with chain codes and using the rough set (RS) method to enhance the ROIs
* Second: segment the mass region from the location ROIs with an improved vector field convolution (VFC) snake
* Feature extraction - 32 dimensions
* Several classification techniques: support vector machine (SVM), genetic algorithm support vector machine (PSO-SVM), decision tree

### Assessment of a novel mass detection algorithm in mammograms

* First step: adpatative thresholding technique
* Second step: false positives are reduced by a machine learning approach

### Automatic Detection of Masses in Mammograms Using Quality Threshold Clustering, Correlogram Function, and SVM

* Quality thresholds
* Correlogram function
* Support vector machine
* Preprocessing: low-pass filter (increases the scale of the contrast), enhancement to the wavelet transform with a linear function
* Segmentation using QT
* Post-processing: selection of the best mass candidates (analyzing shape descriptors through the SVM)
  + Haralick descriptors
  + Correlogram function
* Classification stage: SVM used for training, validation and final test

### Automatic mass segmentation method in mammograms based on improved VFC snake model

* Pre-processing: image enhancement, morphological filter
* Mass location: edge detection (mass location by Hough transform), obtaining mass position parameter
* Mass segmentation: initialization of improved model, calculating the edge map, improved VFC snake segmentation

### Cascio 2014 - Computer-aided diagnosis in digital mammography - comparison of two commercial systems

* Comparison between CyclopusCAD and iCAD
* Standard threshold level
  + CyclopusCAD: sensitivity of 76,9% and 0.73 false positive per image
  + iCAD: sensitivity of 61.5% and 0.28 false positives per image

### Cascio 2014 - Mammographic images segmentation based on chaotic map clustering algorithm

* Chaotic map clustering method

Computer-aided detection and diagnosis of mammographic masses using multi-resolution analysis of oriented tissue patterns

* High-to-low intensity thresholding controlled by radial region growing for the detection of masses
* Multi resolution analysis of orientation of tissue patterns is performed to categorize the masses
* Sensitivity: 85% with 1.4 false positives per image

### Mass Detection and Classification using Machine Learning Techniques in Digital Mammograms

* Pre-processing:
  + Breast border detection: removal of noise (median filter), morphological operation (opening + thresholding + smoothing), edge detection (Canny), multidimensional filtering (Gaussian low pass + binarization + erosion)
  + Locate pectoral muscle
* Mass detection:
  + Image filtering (top hat filter)
  + Compute image entropy (store in X) and grey levels Gs (store in Y)
  + Rank the X (descending) and corresponding Y - array Y stores the optimal tresholds (grey levels) in the descending order
* Mass classification