Segmentation of microcalcifications in regions of interest extracted from mammography by applying partitional clustering algorithms

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Abstract

In recent years, breast cancer has become a topic of interest because it is one of the main causes of death in women. Due to this, this work shows the implementation of a methodology, which is based on digital image processing techniques, such as the segmentation of microcalcifications in regions of interest of digitized mammograms.

The segmentation technique used is based on the PFCM clustering algorithm, which is known as sub-segmentation. This technique at the same time delimits, highlights and detects in a supervised way the possible microcalcifications found in the regions of interest extracted from the mammograms, the images presented and on which the experiments were performed are taken from the mini-MIAS database which are adequately classified by experts.

Introduction

The present work is based on the segmentation of mammography images and the representative patterns (microcalcifications) to help the physician in the early detection of possible breast cancer, by means of partitional clustering algorithms.

Therefore, having a computational tool to support the radiologist in the detection of microcalcifications in mammography images would help the specialist to make a more accurate and earlier diagnosis of breast cancer than if he would only analyze the image. In addition, unnecessary biopsies would be reduced. Mammography is the ideal technique for early diagnosis of breast cancer, because it is non-invasive (non-surgical) and because it can adequately visualize microcalcifications. Thus, a technique is ideal because it allows cancer to be detected before it infiltrates into the surrounding tissue.

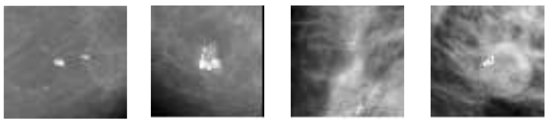
Microcalcifications are small calcium deposits lodged in the breast tissue, and are often primary indicators of the presence of breast cancer. With 30% to 50% of breast cancer worldwide being diagnosed by detection of microcalcifications.

Materials and methods

The software used during the development of the stages proposed in this work was MATLAB® version 7.9 R2009b from which some of the available toolboxes were used.

A block diagram of the implemented methodology is shown below:

Image Reading: Images belong to the mini-MIAS database which are evaluated by experts. For the experiments in this study, 48 images of regions of interest of size 256 × 256 pixels were used.



Data Preparation: It consists of feature extraction from the gray level intensity of the pixels of the original regions of interest, i.e., the raw images. On the other hand, the system aims to extract two sets of d-dimensional patterns of which, one will be the one that best represents the microcalcifications and the other the healthy or normal tissue. The mapping operations from image space to pattern set space (feature space) will be performed one by one i.e., each image pixel for each n-dimensional pattern extracted. This will allow that, when performing a test with an image, the input patterns to be classified, either as healthy tissue class or as microcalcification class, will be the image pixel map.

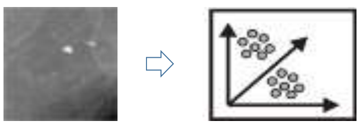


Image Segmentation: For the present work, the techniques based on similarity (Euclidean distance) are used, the result of the clustering can be represented through a segmented image, where each pixel represents a label of the groups in which the data set was divided. This is formed from some or some of the previously defined similarity features. This is because partitional clustering algorithms applied to a dataset aim to find homogeneous groups in the feature space.

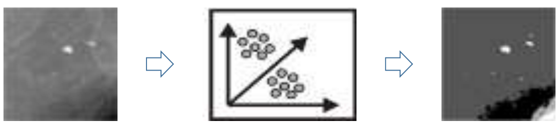
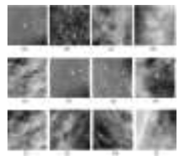


Image Evaluation: Currently there is no quantitative evaluation method, that is why it is done visually, where it is checked against the data obtained from the base.

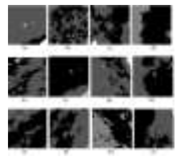
Results

12 ROI images are taken from the mini-MIAS database, in which the experiment is applied, seeing the image that gives us the sub-segmentation and the improvement of the sub-segmentation, this is applied through reference points such as the distance measurement defined as Euclidean, and applying the threshold value, which makes the sub-segmentation of the groups and separates the atypical data from the groups, leaving us only the pixels that correspond to microcalcifications and those that correspond to healthy or normal tissue.

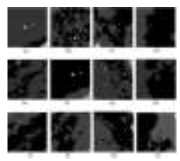
Original ROI images:



The figure shows the results corresponding to the sub-segmentation applied previously where the areas of opportunity already mentioned were found, as can be seen all the pixels are painted in the same color, being that they are of two different classes, one corresponding to Microcalcifications and the other to normal tissue.



The following figure shows the improvement of the sub-segmentation, which gives us the results of the groups with their outlier data for each one, making a partition, applying the threshold value, and thus obtaining the data in the group that corresponds.



Conclusions

In this work we have proposed the segmentation process in which a PFCM clustering algorithm has been used, performing an approach based on a novel technique called sub-segmentation and an improvement of sub-segmentation.

In previous work it had already been visualized that the algorithm had some areas of opportunity and it was improved. Making the correct separation of the pixels, assigning their typical values to each corresponding group, achieving a separation between the microcalcifications and the healthy or normal tissue, taking into account that in the sub-segmentation implemented before the improvement, all the data was not partitioned into a single group taking them as outliers, successfully applying the improvement to perform the experiments and obtain the corresponding results, making a visual evaluation.

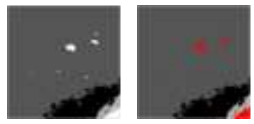


Figure 8 Sub-segmentation

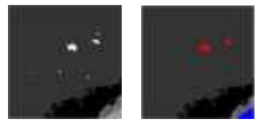


Figure 9 Sub-segmentation improvement

Future of research

- Image enhancement for subsequent segmentation.
- Implement a quantitative evaluation method.
- Compare with other segmentation technique(s).
- Implement a classificator to differentiate pixels corresponding to microcalcification from pixels corresponding to healthy tissue using an Artificial Neural Network.

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