IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-7, July 2019 E-ISSN: 2347-2693

Approach for Segmentation of Micro-calcification in Mammographic Images

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DOI: https://doi.org/10.26438/ijcse/v7i7.2832 | Available online at: www.ijcseonline.org

Accepted: 14/Jul/2019, Published: 31/Jul/2019

Abstract: Ductal Carcinoma (Breast Cancer) is still the most common type of cancer throughout the world and a frequent cause of cancer death among women. Mammography is the most effective and reliable method for accurate detection of breast cancer in recent years. Micro-calcification (MC) is the tiny specks of calcium which appears in the form of clusters in breast tissue. So the detection of MC cluster in breast tissue plays an important role in enhancing the breast cancer diagnosis. In this report, a knowledge-based approach for the automatic detection and segmentation of micro-calcifications in mammographic images is presented. Segmentation is done by using Adaptive Histogram Equalization (AHE) and by calculating range block and domain block of the image. To validate the efficacy of the suggested scheme, simulation has been carried out using Mammography Image Analysis Society (MIAS) database.

Keywords: Adaptive Histogram Equalization (AHE), Mammography Image Analysis Society (MIAS), Micro-calcification (MC), Region of interest (ROI).

I. INTRODUCTION

Cancer is the group of disease which involves the abnormal growth of unwanted cells anywhere in the body. Tumor is the group of cells which is having unregulated growth and will often form a mass or lump, but may be distributed diffusely [1]. Two types of tumor are present one is benign another is malignant. If tumor is diagnosed then, the first step is to find out whether it is malignant or benign, as this will affect your treatment plan. In short, malignant is the cancerous tumor and the benign is non cancerous tumor [2]. Screening is to examine the people in order to detect the disease [3]. For detecting breast cancer in the earliest stages, screening mammography is the single most effective method of all [4] [5]. In mammography technique, very low amount of radiations are delivered to the breasts. Mammograms are used for both screening and diagnosis. To find the breast changes in women who have no signs of breast cancer the screening mammography technique is used. Most women get two x-rays of each breast.

The process to record digital as well as screening mammogram is same, except that digital mammography records the images in computer instead of x-ray film. The images taken in digital mammography are store on the digital chip.

There are five steps of mammogram processing in detection of breast cancer. The steps are pre-processing, segmentation, feature extraction, feature selection and classification. In preprocessing step some noise or artifacts present in an image is removed. Segmentation is main step in which first region of interest (ROI) selection is done. The ROI is nothing but the tumor which is mainly divided for further process. Third step is the feature extraction in which ROI is described in different features like size, shape, intensity and grey level histogram. In the next step, feature selection is done which is used in classification process. The Supervised learning technique of machine learning will be used to do classification [6]. The tumor cell is benign or malignant is classify in the classification process [7].

Breast calcification is the deposits of mineral calcium in breast tissue. They are very common and usually benign (non-cancerous) [8]. The certain types of breast calcification may suggest the breast cancer. There are two types of breast calcification.

a) Macro-calcification

Macro-calcification is the large calcium deposits. These are appear as large white dots on mammogram and often dispersed randomly in the breast tissues.

b) Micro-calcification

Micro-calcification is the small calcium deposits. These are appearing as small white dots on mammogram. Generally these are found in the form of clusters. So, it may be the sign of pre-cancerous cells or early breast cancer.

The detection of MC cluster can be difficult especially in dense tissue. Once the detection process is done then we can go for segmentation which is one of the most significant aspects.

The rest of the paper is organized as follows, Section I contains the introduction of the breast cancer and some required information for segmentation approach, Section II contains related work carried out so far, Section III explains the methodology for proposed approach and flowchart of it, Section IV describes the results and discussions, Section V concludes the research work with future scope.

II. RELATED WORK

Nashid Alam et al., presents an Automatic Segmentation of Micro-calcification Clusters [9]. Early detection of micro-calcification (MC) clusters plays a crucial role in enhancing breast cancer diagnosis. Two automated MC cluster segmentation techniques are proposed based on morphological operations that incorporate image decomposition and interpolation methods. For both approaches, initially, the contrast between the background tissue and MC cluster was increased and subsequently, morphological operations were used. An evaluation was based on the Dice similarity scores and the results of MC cluster classification. The paper has presented a new technique for MC cluster segmentation using a series of morphological operations. The proposed approach was focused on the improvement of the accuracy of MC cluster segmentation to facilitate the final output of a CADx pipeline, by selecting the most salient features from the segmented image.

Tomasz Arod´z et al., present a new computer-aided detection system for small field digital mammography in planning of breast biopsy [10]. The most frequent symptoms of ductal carcinoma recognized by mammography are clusters of micro-calcifications. Their detection from mammograms is difficult, especially for glandular breasts. The system processes the mammograms in several steps. First, filter the original picture with a filter that is sensitive to micro-calcification contrast shape. Then, enhance the mammogram contrast by using wavelet-based sharpening algorithm. Afterwards, the results are present to radiologist, for visual analysis, such a contrast-enhanced mammogram with suggested positions of micro-calcification clusters. This paper proposed a computer system devised to support a radiologist in small field digital mammography for planning of breast biopsy. This paper focused on the detection of clusters of micro-calcifications. The proposed algorithm operates in several phases. First, the suspicious regions in the mammogram are detected. Then the contrast of the whole mammogram is enhanced. Finally, the contrast-enhanced image with suspicious regions marked is presented to the radiologist. The radiologist can attenuate the micro-calcifications with isoline visualization technique.

Arnau Oliver et al., presents a knowledge-based approach for the automatic detection of micro-calcifications and clusters in mammographic images [11]. The proposal is based on using local features extracted from a bank of filters to obtain a local description of the micro-calcifications morphology. Subsequently, the micro-calcification detection method is extended in order to detect clusters. The validity of this approach is demonstrated using two digital databases and one full-field digital database. The experimental evaluation is performed in terms of ROC analysis for the micro-calcification detection and FROC analysis for the cluster detection, resulting in better than 80% sensitivity at 1 false positive cluster per image.

This paper presents a new fully automatic computer aided detection system for micro-calcification detection. The core of the system is based on extracting local features for characterizing the morphology of the micro-calcifications. Afterwards, the proposed approach follows a boosting scheme, allowing the selection of the most salient features at each round. At the testing stage, only these features are computed and used to detect the individual micro-calcifications. Subsequently, the cluster detection is performed by locally integrating the individual micro-calcifications probability images.

Ilhame Ait Ibachir et.al presents a survey on segmentation techniques of mammogram images. Visualization of breast cancer is done by using an important tool named as mammogram [12]. In mammogram images radiologists can clearly view the suspicious area i.e., our Region of Interest (ROI) which represents the tumor. Computer aided Diagnosis system (CAD) software is used to analyze the mammogram images in medical field. To extract the ROI from mammogram the segmentation method is used. As segmentation method is pre processing step for feature extraction, feature selection and classification, the proper implementation of this method is an important task. So, in this paper different approaches for segmentation methods are given theoretically. The advantage and disadvantage of various methods is also present. So, with the help of this comparison is done and which method is suitable for mammogram segmentation is evaluate easily.

Xiaoli Zhang Xiongfei Li Yuncong Feng presents a Medical Image Segmentation Algorithm Based on Bi-directional Region Growing [13]. In medical image processing and analysis image segmentation is one of the vital researching branches. This paper proposes a bi-directional region growing segmentation algorithm by considering the characteristics of medical images. The easiness of initial seed selection and robustness to noises and the order of pixel processing are including in the interest of algorithm. This

method is used for other segmentation applications in which background region is simple but target region is complex. The issue of threshold selection is converted to Minimization problem with the assistance of statistical properties of transformation matrix. In this paper, a straightforward translation of region growing segmentation for medical image segmentation, which is denoted as bi-directional growing segmentation algorithm is present.

Zhi Luz Gustavo et al., presents an automated detection of individual micro-calcifications from mammograms using a multi-stage cascade approach In mammography [14], the efficacy of computer-aided detection methods depends, in part, on the robust localization of micro-calcifications (micro-calcification).

This paper proposes a novel approach to micro-calcification detection, consisting of the detection and classification of individual micro-calcification candidates, using shape and appearance features, using a cascade of boosting classifiers. The final step in our approach then clusters the remaining individual micro-calcification candidates. The main advantage of this approach lies in its ability to reject a significant number of false positive micro-calcification candidates compared to previously proposed methods. In advance this paper presents a new micro-calcification detection pipeline that introduces a step that effectively filters out individual false positive micro-calcification detections using shape and appearance features in a cascade of boosting classifiers. This paper shows that method displays a significantly more effective detection of individual micro-calcifications compared to the current state-of-the-art approach. This has the potential to improve the mammogram analysis in breast screening programs.

K. Kavitha, Dr. N. Kumaravel presents A Comparitive Study of Various Micro-calcification Cluster Detection Methods in Digitized Mammograms [15]. A new approach to the problem of micro calcifications detection in digital mammograms is introduced. Using the proposed criterion with a integrated approach using filter bank, DCT and bayesian classifier, experimental results showed that a higher classification accuracy than ordinary techniques is achieved. The proposed technique also reduces the complexity of the detection process.

III. PROPOSED APPROACH

In related work methods, a series of morphological operations were applied to segment MC clusters [9]. Two different segmentation methods were proposed for MC cluster segmentation - where the second approach was built on the results of the first technique. Bi-cubic interpolation method and area ranking technique was used.

In our proposed work instead of using Bi-cubic interpolation and area ranking technique we are using Adaptive Histogram Equalization method and K-means algorithm is used. The flowchart of proposed work is shown in fig. 1. In proposed work, adaptive histogram equalization and range block and domain block are calculated. Mainly the thresholds T1 and T2 are calculated then the binarization process is done.

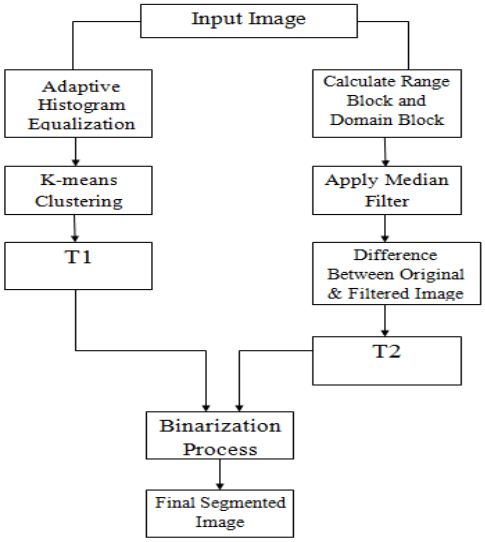

Figure 1 Flowchart of proposed work

3.1 Calculation of T1

Adaptive Histogram Equalization

Histograms are calculated by using details of each and every pixel in the image. In histogram equalization contrast adjustment process is done on image. The intensity of the image can be better distributed on histogram by using contrast adjustment process. Adaptive histogram equalization is same as histogram equalization except AHE calculates several histograms each corresponds to different section of image and uses them to redistribute the lightness value of image. AHE is better than histogram equalization as it is suitable for increasing local contrast of an image and enhancing the image. Adaptive histogram equalization is evaluated by considering foreground pixel only. AHE uses gray mapping of pixel in the image by using gray operations and transforms the histogram into uniform, smooth and which has clear gray level values so the purpose of image enhancement can be easily achieved.

Now, k-means clustering is apply on the image receive by using adaptive histogram equalization algorithm. K-means clustering is used to partition n observations into k clusters in which each observation is belong to the cluster with nearest mean. In k-means clustering initialization of centroid is an important task. To calculate the distance between centroids Euclidean distance method is used. By using this k-means clustering algorithm T1 is generated.

3.2 Calculation of T2

In the fig. 1 shows the steps to calculate T2. First an image is partitioned into non-overlapping cells as range blocks. Then, the image is also divided into overlapping sub blocks which are domain block. Each range block is mapped with domain block shown in fig. 2. Generally, the domain block has double size of range block. For each domain block, we map a square domain cell to a square range cell.

The next step is to apply the median filter. Median filter is applied on the modeled input image so we get the filtered image. To remove noise from image the on linear digital filtering technique which is median filter is used. This is the pre processing step for the next step which is to calculate the difference between the modeled image and filtered image.

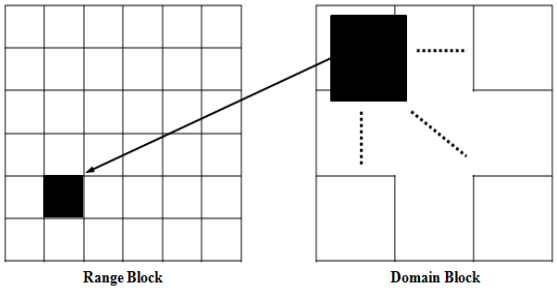

Figure 2 Range and domain block

Binarization Process

Binarization is the method of converting any gray scale image into black and white image. If gray level pixels are greater than threshold then those pixels are converted into the white pixel. Similarly, if gray value is less than threshold then those pixels are converted into black pixel. In binarization process the output images T1 and T2 are added by using logical AND operator.

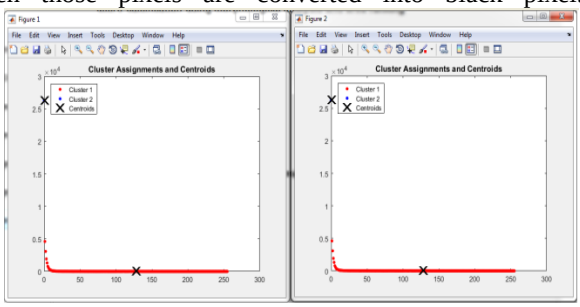

Figure 4 Intermediate operations in proposed work i.e., cluster assignments and centroids

The fig. 5 shows the graph for comparison of results between related paper work [9] and the proposed work. The results are calculated by using different parameters like recall, precision, accuracy and F-score. The Table 1 shows the exact values of all the above parameters which are calculated on related work and proposed approach.

IV. RESULTS AND DISCUSSION

The segmentation process is done by using AHE and by calculating range and domain block. The evaluation is done with MIAS dataset. The following fig. 3 shows the output which is final segmented image. In fig.3, input image is mammogram image. The modeled input image is obtained by using evaluation of range block and domain block. Difference image is the result of difference between modeled image and filtered image. Now T2 is display as result. After applying adaptive histogram equalization and k-means clustering the T1 image is generate. By using binarization process the final segmented image is generated as output. The fig. 4 shows the cluster assignments and centroids in intermediate steps.

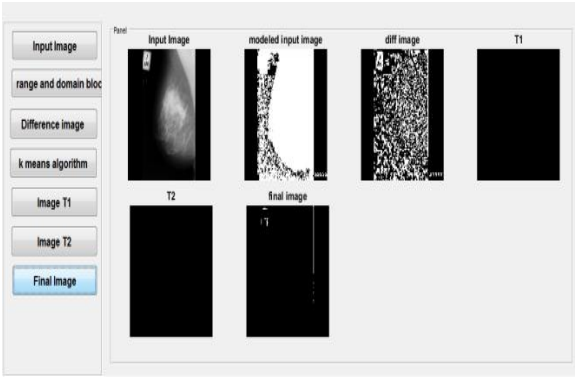

Figure 3 Result analysis of proposed work

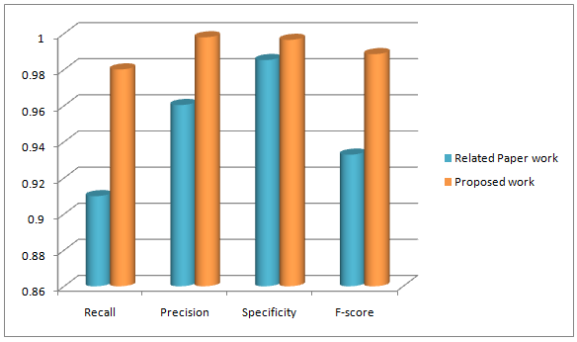

Figure 5 Graph for comparison of results

Table 1 Result of related work and proposed work

	Base Paper Result	Proposed Work Result
Recall	0.9099	0.9801
Precision	0.9604	0.9979
Specificity	0.9853	0.9965
F-score	0.9329	0.9886

V. CONCLUSION

Micro-calcification (MC) clusters are small granular deposits of calcium that appear in a mammogram as bright dots. The detection of MC clusters can be difficult, especially in dense tissues. In the related work approach, a series of morphological operations were applied to segment MC clusters. Two different segmentation methods were proposed for MC cluster segmentation - where the second approach was built on the results of the first technique. Bi-cubic interpolation method and area ranking technique was used. In our proposed work instead of using Bi-cubic interpolation and area ranking technique we are using Adaptive Histogram Equalization method and K-means algorithm is used. We are evaluating results on the MIAS dataset.

We are using proposed method on MIAS dataset and then we finalize our results based on the parameters like precision, recall, specificity and F-score. From the results we have analyze that the proposed approach gives the better results than previous work. Our proposed system easily segments the micro-calcification cluster from mammogram and giving better results than previous work.

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