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Tumor Detection in Mammography Images using Vector Quantization Technique

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Abstract- **X-ray mammography is the most common investigation technique used by radiologists in the screening, and diagnosis of breast cancer. The ability to improve diagnostic information from medical images can be enhanced by designing computer processing algorithms that is why we proposed new algorithm to detect cancer in mammogram breast cancer images. In this paper we proposed segmentation using vector quantization technique. Here we used Linde Buzo and Gray (LBG)for segmentation of mammographic images. Initially a codebook of size 128 was generated for mammographic images. These code vectors were further clustered in 8 clusters using same LBG algorithm. These 8 images were displayed as a result. This approach does not leads to over segmentation or under segmentation. For the comparison purpose we displayed results of GLCM and watershed segmentation along with this method.**

Index Terms- **Mammography, segmentation, tumor detection, LBG.**

I. INTRODUCTION

Breast image analysis can be performed using X-rays, magnetic resonance , nuclear medicine or ultrasound. So far the most effective and economical breast imaging modality has been X-ray mammography due to its simplicity, portability and cost effectiveness. Segmentation is the fundamental process which partitions a data space into meaningful salient regions. Image segmentation essentially effects the overall performance of any automated image analysis system thus its quality is of the utmost importance.

Recent studies showed that the interpretation of the mammogram by the radiologists give high rates of false positive cases Indeed the images provided by different patients have different dynamics of intensity and present a weak contrast. Moreover the size of the significant details can be very small. Several research works have tried to develop computer aided diagnosis tools. They could help the radiologists in the interpretation of the mammograms and could be useful for an accurate diagnosis. In order to perform a semi-automated tracking of the breast cancer, it is necessary to detect the presence or absence of lesions from the mammograms[1,2].These lesions can be of various types: - Nodular opacities, clear masses with lobed edges etc. They can be benign or malignant, according to their contour (sharp or blurred)- Stellar opacities (malignant tumors); micro calcifications: small calcified structures that appear as clear points on a mammogram [3,4].

For mammograms manifesting masses this corresponds to the detection of suspicious mass regions. A number of image processing methods have been proposed to perform this task. S. M. Lai et al [5] and W. Qian et al [6] have proposed using modified and weighted median filtering, respectively, to enhance the digitized image prior to object identification. D. Brzakovic et all [7] used thresholding and fuzzy pyramid linking for mass localization and classification. Other investigators have proposed using the asymmetry between the right and left breast images to determine possible mass locations. Yin ***et** al.* uses both linear and nonlinear bilateral subtraction [8] while the method by Lau ***et** al.* [9] relies on "structural asymmetry" between the two breast images. Recently Kegelmeyer [10] has reported promising results for detecting spiculated lesions based on local edge characteristics and Laws texture features [11-12].The above methods produced a true positive detection rate of approximately 90%.The work we have done is to propose a segmentation process which identifies on a mammogram the opaque areas, suspect or not, present in the image using vector quantization.

Image segmentation is, by definition, the problem of decomposing images into regions that are semantically uniform. However, since images themselves provide only semantically poor information, image segmentation is essentially an application-oriented problem that demands either strong intervention of human experts or application specific solutions. In other words, no fully automatic, general-purpose segmentation method exists.

Segmenting a mammographic images into homogeneous texture regions representing disparate tissue types is often a useful preprocessing step in the computer-assisted detection of breast cancer. Various segmentation techniques have been proposed based on statistically measurable features in the image [13-17].Clustering algorithms, such as k-means and ISODATA, operate in an unsupervised mode and have been applied to a wide range of classification problems[18].

The choice of a particular technique depends on the application, on the nature of the images available (texture, ill-defined contours,, shadows), on the primitives to be extracted (contours, straight segments, regions, shapes), number of objects need to be segmented, the amount of available user time, and the required accuracy of the segmentation.. We are introducing vector quantization for image Segmentation which consumed moderate time but provide good accuracy with less complexity. Watershed algorithm has a drawback of over-segmenting the tumor also in different segments making it obscure for identification. Another method using Gray level co-occurrence matrix also gives oversegmetation.

A. *Vector Quantization*

Vector Quantization (VQ) [19-27],[52-54] is an efficient technique for data compression and has been successfully used in various applications such as index compression [28, 29]. VQ has been very popular in a variety of research fields such as speech recognition and face detection [30, 31]. VQ is also used in real time applications such as real time video-based event detection [32] and anomaly intrusion detection systems [33], image segmentation [34-37], speech data compression [38], content based image retrieval CBIR [39] and face recognition [40].

Vector Quantization (VQ) techniques employ the process of clustering. Various VQ algorithms differ from one another on the basis of the approach employed for cluster formations. VQ is a technique in which a codebook is generated for each image. A codebook is a representation of the entire image containing a definite pixel pattern which is computed according to a specific VQ algorithm. The image is divided into fixed sized blocks that form the training vector. The generation of the training vector is the first step to cluster formation on these training vectors clustering methods is applied and codebook is generated. The method most commonly used to generate codebook is the Linde-Buzo-Gray (LBG) algorithm which is also called as Generalized Lloyd Algorithm (GLA).

The rest of the paper is organized as follows. Section II describes Gray level Co-occurrence Matrix, the Watershed and Linde Buzo and Gray (LBG) algorithm used for image segmentation of mammographic images. Followed by the experimental results for mammographic images are in section III and section IV concludes the work.

II. ALGORITHMS FOR SEGMENTATION

It is difficult, however, to compare the effectiveness of these methods because each used a unique set of digitized mammograms and the results varied between training and testing.

In this section we explain segmentation by Gray level co-occurrence matrix , basic watershed algorithm [41-45] and Linde Buzo and Gray algorithm [46-48] which we used for tumor detection

A. *Gray Level Co-occurrence Matrix*

Haralick [49] suggested the use of gray level co-occurrence matrices (GLCM) for definition of textural features. The values of the co-occurrence matrix elements present relative frequencies with which two neighboring pixels separated by distance *d* appear on the image, where one of them has gray level *i* and other *j*. Such matrix is symmetric and also a function of the angular relationship between two neighboring pixels. The co-occurrences matrix can be calculated on the whole image, but by calculating it in a small window which scanning the image, the co-occurrence matrix can be associated with each pixel. By using gray level co-occurrence matrix we can extract different features like probability, entropy, energy, variance, inverse moment difference etc. For this paper we extracted entropy using gray level co-occurrence matrix and displayed here as a result in Fig.3(a) in comparison with watershed and LBG algorithms.

B. *Watershed algorithm*

Watershed segmentation [50] classifies pixels into regions using gradient descent on image features and analysis of weak points along region boundaries. The image feature space is treated, using a suitable mapping, as a topological surface where higher values indicate the presence of boundaries in the original image data. It uses analogy with water gradually filling low lying landscape basins. The size of the basins grow with increasing amounts of water until they spill into one another. Small basins (regions) gradually merge together into larger basins. Regions are formed by using local geometric structure to associate the image domain features with local extremes measurement. Watershed techniques produce a hierarchy of segmentations, thus the resulting segmentation has to be selected using either some prior knowledge or manually. These methods are well suited for different measurements fusion and they are less sensitive to user defined thresholds. We implemented watershed algorithm for mammographic images as mentioned in [51].Results for mammographic images are displayed in Fig3(b).

C. *Linde Buzo and Gray Algorithm (LBG)*

For the purpose of explaining this algorithm, we are considering two dimensional vector space as shown in Fig.1. In this algorithm centroid is computed as the first codevector C_1 for the training set. In Fig. 1 two vectors v_1

& v_2 are generated by adding constant error to the codevector. Euclidean distances of all the training vectors are computed with vectors v_1 & v_2 and two clusters are formed based on nearest of v_1 or v_2. Procedure is repeated for these two clusters to generate four new clusters. This procedure is repeated for every new cluster until the required size of codebook is reached or specified MSE is reached.

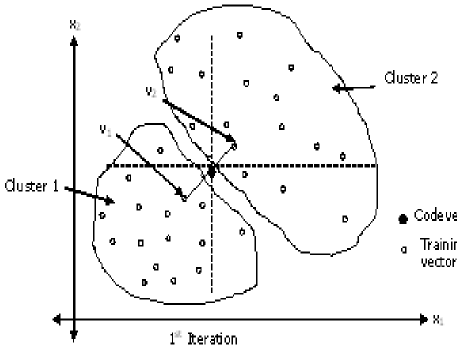


Fig.1. LBG for 2 dimensional case

Using this algorithm initially a codebook of size 128 was generated for the given images. These code-vectors were further clustered in 8 clusters using same LBG algorithm.The 8 images were constructed using one code-vector at a time. These 8 images display different segments depending on the textural property of the image. It is observed that the image constructed using first code vector displays tumor clearly.

III. .RESULTS

Mammography images from mini-mias database were used in this paper for implementation of GLCM, watershed and LBG algorithms for tumor demarcation.Fig.2(a) shows original image with tumor. For this image we generate codebook of size 128 using LBG algorithm. Further these code-vectors were clustered in 8 clusters using same algorithm. Then 8 images were constructed using one code-vector at a time as shown in Fig.2(b)-(i). Fig.3 (a) shows results for equalized entropy using gray level co-occurrence matrix.Fig.3(b)shows result for watershed algorithm and Fig.3(c) indicate result for first code-vector amongst 8 code-vectors using LBG algorithm.Fig.4(a)-(c) displays canny edge detected image for image Fig.3(a)-(c) respectively for comparison purpose.

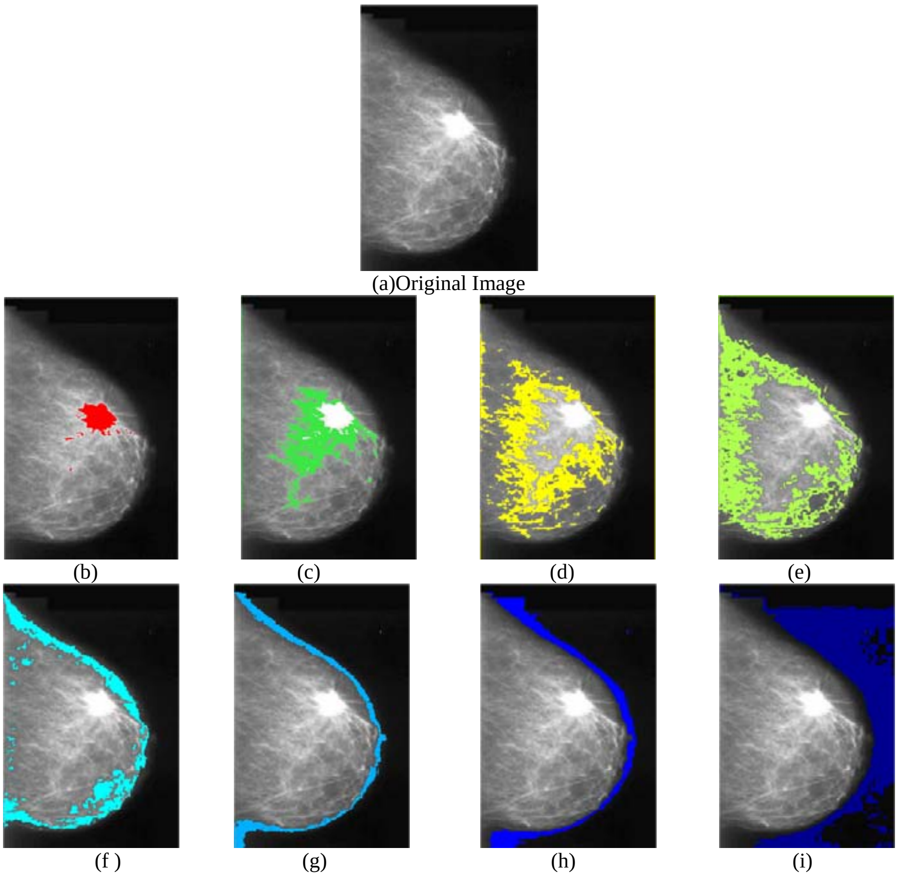
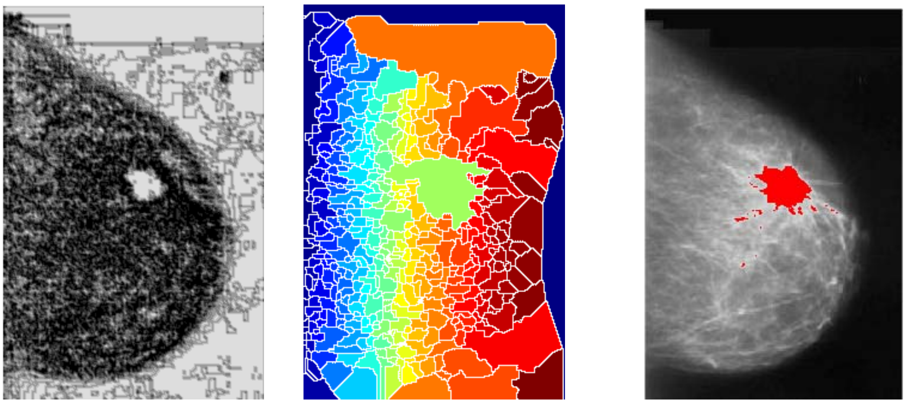
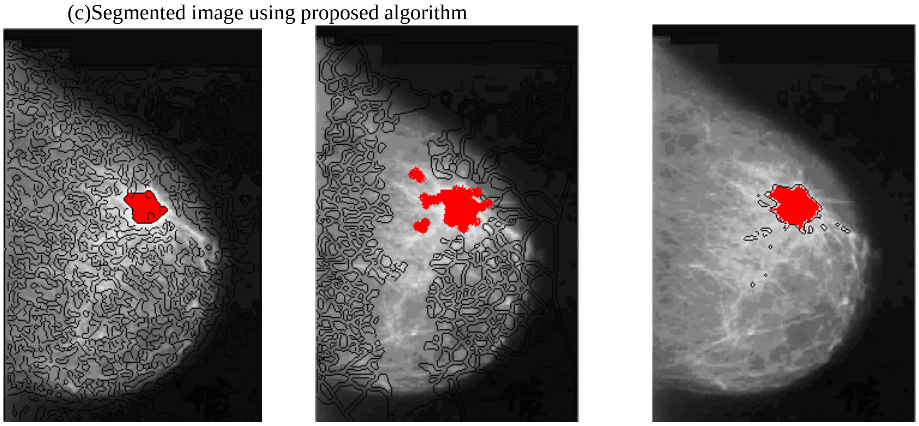


Fig. 2: (a) Original breast tumor image,(b) Image for first code-vector, (c)Image for second code-vector, (d)Image for third code-vector, (e)Image for fourth code-vector, (f)Image for fifth code-vector, (g)Image for sixth code-vector, (h)Image for seventh code-vector, (i)Image for eighth code-vector,



(a) (b) (c)

Fig.3: (a) Segmented image for entropy using GLCM, (b) Segmented image using watershed algorithm, (c)Segmented image using proposed algorithm



(a) (b) (c)

Fig.4 : (a)-(c)Superimposed images Fig3(a)-(c) on original image fig.2(a)

IV. CONCLUSION

In this paper we have used vector quantization which is commonly used for data compression. Basically vector quantization is a clustering algorithm and can be used for texture analysis. Here we are giving the results of LBG algorithm for tumor detection in mammographic images. The results are compared with well known watershed algorithm and GLCM. Initially a codebook of size 128 was generated for these images. These code vectors were further clustered in 8 clusters. These 8 images were displayed as a result in Fig 2(b)-(i). From results (Fig.4) it is observed that watershed and GLCM give over segmentation while LBG shows far better results for the same. This approach does not lead to over segmentation or under segmentation.

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