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Feature extraction and segmentation of medical images for MRI and Digital mammogram

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Abstract:
Background: Developing a computer aided diagnosis system (CAD) is an extremely challenging task. One of the major goals of CAD is to help the radiologist to make good decisions by detecting and analyzing characteristics of benign and malignant lesions. In this context, we present accurate and automatic method that, detect and extract malignancy descriptors of breast and meningioma brain tumor.
Methods: We applied an algorithm that uses enhancement image based on homomorphic filtering and adaptive histogram equalization technique. A region of interest is determinate using K means clustering. Then, we employed wavelet transform to extract pertinent features for meningioma tumor, geometric and texture characteristics for breast tumor in order to classify malignancy lesion.
Results: the segmentation result has been shown in this paper showing the well segmented masses, as well as the extracted set of characteristics has been illustrated in a vector .
Conclusion: A features extraction and segmentation of mass cancer and meningioma brain Tumor images are presented in this paper. Future work should focus on extraction of pertinent information witch characterize the malignancy. In order to increase the classification accuracy, we plan to explore a large data set of real images. Then, to evaluate performance of our method, we will compare the recent work proposed in literature.
Keywords: CAD; breast tumor; meningioma brain tumor; feature extraction; segmentation.

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1. Introduction

Nowadays, cancer is a most eminent public health problem in the world. According to the world health organization (WHO), breast cancer and meningioma brain tumor are considered as most common primary cancer in adults [1]. Moreover, they recur despite aggressive treatment, leading to substantial morbidity. Standard-of-care management typically involves surgical resection and often radiation therapy for high-grade.
Medical image analysis plays an important role in assessing the spatial organization of different tissues. Especially, the identification of tissue as normal, benign or malignant. This classification can help clinicians by giving a second opinion improving diagnostic accuracy and reduce human error.
Here, we present three steps of CAD system used for tumor extraction for mammography images and MRI images. To achieve this, we propose a method for pre-processing to delete noise and to improve the contrast between different anatomical structures. Homomorphic filtering is applied to the input image for improving the contrast of image. In addition, morphological operations are applied to remove the noise and to smooth the edges of the image. This method was inspired from work proposed in [2]. The K-Means clustering algorithm and morphological operators has been used to segment mass and extract the border witch is a both robust and successful approach. Finally, we proceeded to the extraction of geometric and texture features for digital mammograms and wavelet transform to extract pertinent features for meningioma tumors.

2. Methods

The proposed segmentation model includes three main steps. The initial step aims to delete noise and improve the contrast between different anatomical structures. Homomorphic filtering, which is applied to the input image to improve the contrast of image and morphological operations are applied to remove the noise and to smooth the edges of the image. K-Means clustering algorithm and morphological operators have been used to segment mass and extract the border, which is robust and successful approach. Then, we proceeded to the extraction of geometric and texture features for digital mammograms and wavelet transform to extract pertinent features for meningioma tumor. In this section, the different steps of the proposed method are explained. The implementation of our model was performed on a data set of real patients.

Brain MRI data

The dataset was acquired from the CHU La Cavale Blanche, Brest-FRANCE and from haravad school site at https://nac.spl.harvard.edu/downloads. The MRIs are sampled by 3.0 Tesla Philips Medical System. The dataset was scanned by two different MRI modalities, the slices have dimensions of 256*256 Pixels.

Digital mammogram data

The mammogram used in the experiments is taken from the mini mammography database of MIAS, where the masses are regrouped either speculated, circumscribed or well-defined .The original MIAS Database (digitized at 50 micron pixel edge) has been reduced to 200 micron pixel edge and clipped/padded so that every image is 1024 pixels x 1024 pixels.

2.1 Preprocessing

Intensity normalization is an important step in preprocessing of MR images. In this Article we used an algorithm based on hybrid approach combination of both frequency domain homomorphic filtering and a spatial domain morphology as described by[3] and an adaptive histogram equalization technique to the output of hybrid approach.
The steps of the approach are defined as follows:
***step1**:* Apply homomorphic filter to compress brightness range and enhance contrast of image.
Figure 1 shows the steps in homomorphic filtering process

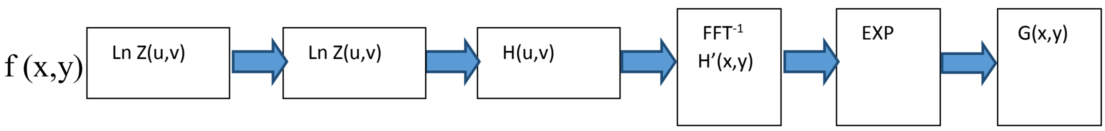

Fig.1.Homomorphic Filter

f(x, y): an input image.
Z(x, y) : output after log transformation. Z (u, v) is the output of Fourier transform.
H (u, v) : transfer function of frequency domain filter.
H' (u ,v) :output of the Z(u, v) filtered with H(u,v). Exponential is applied to the H'(x,y) to get the output G (x, y).
H (u, v) = (rH - rL) [1-exp(c (D/D02)] Where rH is the regulation parameter to change high frequency, rL is regulation of parameter to change low frequency, where rH>1 and rL<1, c is sharpening parameter and D is balance parameter. rH =1.414 and

rL=0.18.

D (u, v) =u2+v2, D0 is harmonic coefficient, D0 = ((max-μ)2+ (min-μ)2)/ a

Step2*:* Tophat transform is applied to G using disk of radius 15 as a structuring element. Shape and size of structuring element is selected based on the shape and size of the masses. It can be used to separate the objects. Let the output be thf.

Step 3*:* Dilation operator on a binary image is to gradually enlarge the boundaries of regions of foreground pixels**.** It is applied to smooth the borders of tophat transformed image. Let the output be thf1.

Step4*:* Bothat transform is applied to the original image to smooth the objects in original image. Let the output be bhf.

Step 5**:** These images are combined using Image arithmetic addition and subtraction. Enhanced image = (G+thf1) – (bhf)

Step6*:* Adaptive histogram equalization technique is applied to improve local contrast.

2.2 Segmentation

To detect automatically the tumor and treat only the region of interest and not all pixels in images we used the K-Means clustering algorithm and morphological operators to segment mass and extract the edge.

The k means-clustering algorithm uses iterative refinement to produce a final result. The algorithm inputs are the number of clusters and the data set input is image pixels and their descriptor are their grey level values. Euclidean distance has been chosen as distance.

2.3 Feature Extraction

For brain tumor, the wavelet transform has become a major image characterization tool. We used Discrete Wavelet Transform to extract pertinent features that describe malignant lesion. The reduced features were submitted.

In fact, according to the BIRADS, benign masses have a round or oval shape and a circumscribed or micro lobulated contour, while malignant masses usually have a lobed or irregular shape and an indistinct or speculated contour. Therefore, we extract geometric features such as: Circularity Index, Area, Perimeter P: A: is the ratio of perimeter to the area of the lesion. L: S Ratio: is the length ratio of the major (long) axis to the minor (short) axis of the equivalent ellipse of the lesion. If L: S ratio is more, it is likely the lesion is malignant. E: N (Elliptical normalized circumference): Anfractuosity is a common morphological feature for malignant contour. ENC is the circumference ratio of the lesion and its equivalent ellipse. Anfractuosity of a lesion contour is characterized by ENC. and we opted for the extraction of texture descriptor that are important for the distinction of the normal tissue from the cancerous one , for this we use a gray level co-occurrence matrix.

The steps of the approach are defined in Fig2.

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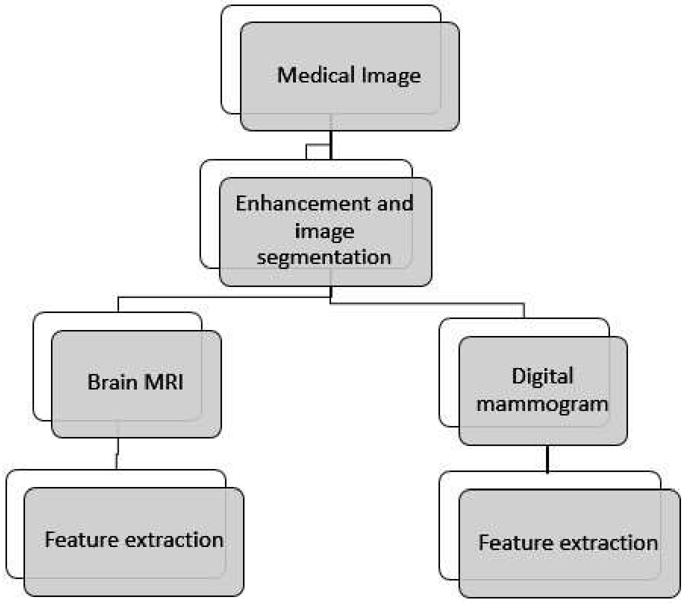

Fig.2. Proposed method

3. Results and discussion

In this section, we present the results of our approach, starting with the preprocessing which is illustrated in Fig 3.

a)

b)

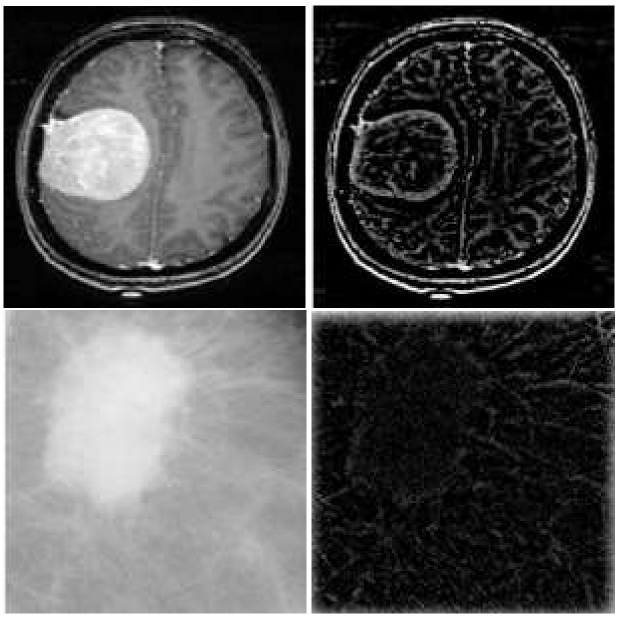

Fig 3. a) Original and Enhaced MRI b) Original Mammogram and Enhaced Mammogram.

Then the ROI's determination are given in the figure below,

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a)

b)

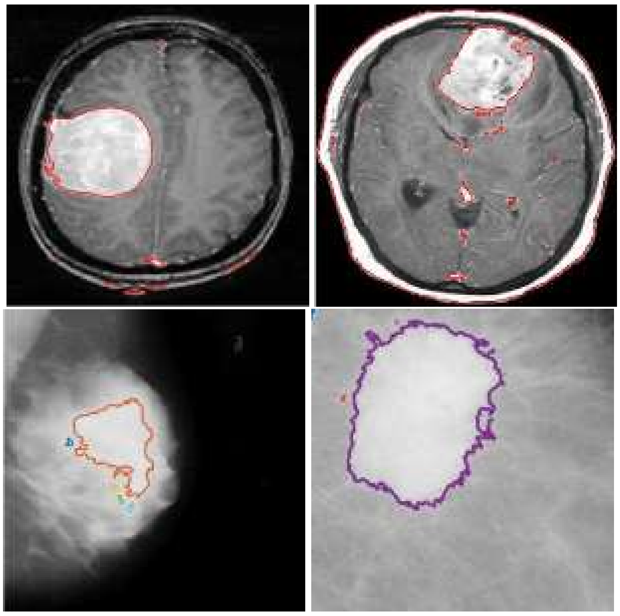

Fig.4.a) Result of brain lesion b) Result of breast lesion.

The following table shows the values of the extracted descriptors.

Patient No	Area	*Perimeter*	*P: A*	*L: S Ratio*	ENC	*Circularity Index:*
B1 (benign)	3	1,9544	1,031	2,582	1,7638	1,7638
B2	6	2.7640	0.9193	3.4641	2.3094	1.5000
B3	1	1.1284	0	1.1547	1.1547	1
M1(Malignant)	1	1.1284	0	1.1547	1.1547	1
M2	2	1,1285	0,9264	3,6477	1,2728	1
M3	3	1,0857	0,9645	2,6747	1,3245	1,2554

Patient N°	Contrast	Correlation	Energy	Homogeneity	Mean	SD	Entropy	IDM
B1	1,7638	1,7638	1,7638	1,7638	1,7638	1,7638	1,7638	-1,394
B2	8.6832	0.1782	0.8072	0.9470	0.0028	3.4723	7.6167	0.7711
B3	3.5449	0.2469	0.8408	0.9545	0.0023	2.7198	18.8132	-0.5976
M1	3.5449	0.1859	0.8129	0.9478	0.0016	3.3274	9.0122	0.7791
M2	3.5449	0.3728	0.8775	0.9634	0.0044	1.6034	51.1445	3.2882
M3	18.4199	0.3092	0.8646	0.9614	0.0030	2.0780	36.5215	1.9469

Fig 5. Vector characterization

The purpose of our work is to have good preprocessing results and efficient descriptors in order to obtain better classification model, we aim to compare our results through many classifiers like KNN and SVM essentially with the machine learning.

4. Conclusion

A features extraction and segmentation of mass cancer and meningioma brain Tumor images are presented in this paper. The proposed method is mainly based on Zhang et al. [3] Future work should focus on extraction of pertinent information that characterize the malignancy. In order to increase the classification accuracy, We plan to explore a large data set of real images. Compare our results with machine learning classifiers to find the most appropriate one for our approach.

5. Conflict of interest statement

We certify that there is no conflict of interest with any financial organization in the subject matter or materials discussed in this manuscript.

6. Authors' biography

No Biography

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