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IOT based Breast Cancer Monitoring using MRI images Post Neoadjuvant Therapy

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***Abstract*—** Metastatic cancer remains a key task in medical management of the disease, since most cancer mortality rates are accredited to metastatic spread of cancer rather than the primary tumor. Despite the noteworthy improvements in the diagnosis, treatment and clinical management, prediction of prognosis, breast cancer relapse and death rates remain unacceptably high in women worldwide. Magnetic Resonance Imaging serves as an important source in detection, diagnoses and treatment monitoring of Breast Cancer. Image processing techniques like pre-processing using different filters to remove the noise content, image segmentation methods to extract the feature such as major axis length, minor axis length are applied to breast MRI images. A mobile app is developed to send the pre-processed MRI images to the doctors' smart phone. The aim is to augment the view of the MRI images and interpret the condition of the patient as well as to enrich the overall interpretation process. The objective of the work is the analysis of MRI images which reflect the response of the neoadjuvant therapy administered at each successive stage to breast cancer patients in steps.

***Keywords*—** Metastatic Breast Cancer, Neoadjuvant therapy, Magnetic Resonance Imaging, Image processing.

I. INTRODUCTION

Breast Cancer has been grabbing the attention of medical and scientific communities because of its high prevalence and associated with the difficulty in treatment in recent years. Metastasis of breast cancer is the spread of malignancy to other parts of the body and is associated with high mortality rate. The monitoring and treatment of Metastases still remains a challenge in the medical field.

Tumors that are missed by conventional techniques like mammography or ultrasound can be detected by MRI and it is better at correctly assessing tumor size and detecting additional foci of disease (multi- focal or multicentric cancers, or both), and it is good at detecting abnormalities in the dense breasts.

The image presentation is a key advantage of MRI. Three dimensional MIP (Maximum Intensity Processing) images allow a view through the breast, which can be useful in assessing the effect of the contrast agent. Isotropic resolution imaging permits a view of the inside of breasts from multiple directions or orientations, which assists in defining the extent of the disease

Currently, the examination of the breast MRI images is approved by pathologist. For better identification and diagnosis of the condition of the patient, an image processing tool developed in which the MRI images undergo pre- processing and segmentation to extract the features of the tumor like major axis length and minor axis length.

Preoperative chemotherapy for induction of the tumor shrinkage is called Neoadjuvant chemotherapy (NAC) [2] and is progressively used in recent times for the supervision of breast cancer. NAC is a therapy given before surgery to make decision by the oncologists on breast conservative surgery. Reaction of tumor to NAC is a valuable predictor of patients' survival rate.

The response of Neoadjuvant therapy found by MRI images procured is classified according to a criteria known as RECIST (Response Evaluation Criteria in Solid Tumors (RECIST) criteria based on Investigations done to measure the diameter of the tumor in two dimensions [1]. It is categorised into four type of responses

i) Complete response- less than 10mm reduction in minor axis.
ii) Partial Response- minimum 30% reduction in major axis.
iii) Progressive disease- minimum 20% increase in major axis.

iv) Stable Disease- adequate increase or decrease in longest diameter is not found.

A personal computer with sophisticated software is required to carry out processing on the MRI acquired images. The analysis of the MRI images is either done by pathologist or the hard copy of the images are observed by the oncologists to determine the further course of action of the treatment. The measurement of the features of the tumor like tumor size, major axis diameter, minor axis diameter, depth and volume of the tumor cannot be done from the hard copy, hence restricts the oncologists from getting the exact diagnostic information.

II. RELATED WORK

Mario Mustra et al. [3] focuses on determination of microcalcifications in the mammogram images. The extraction of the microcalcifications in the mammogram images is a difficult proposal. Several false diagnosis of microcalcifications occur while extracting this feature. The methods used in the system to accurately detect microcalcifications are as follows:

- The background noise in the image is eliminated by a method called contrast enhancement
- This is made possible by two methods namely, wavelet sieving and grayscale morphology.
- Automatic selection of doubtful areas is executed unlike present methods which uses manual selection.

Different filters used for elimination of the background noise in the images is explored in our research work based on the information provided in this literature.

Bhagyashri G. Patil et al. [4] focuses on two methods of segmentation such as thresholding and watershed are used to detect the cancer cell and to find out better approach out of them. The steps involved are Image Enhancement stage, Image Segmentation stage and Features Extraction stage. The results of the image processing techniques show that Marker- Controlled Watershed Segmentation approach has more accuracy (85.27%) and quality than Thresholding approach (81.24%).

Sivaranjini S and Nirmala K [5] have worked on the response given by breast cancer patients to pre-operative Chemotherapy. It is analysed with MRI images of patients undergoing neoadjuvant therapy. The following steps were adopted to attain the objective;

- The filtering of the MRI images is performed Gaussian adaptive k means clustering is used for the identification segmentation of region of interest and extraction of features.
- The treatment plan is derived by the classifying the features extracted from the pre-processed image.
- The longest diameter is learnt to be the major prognostic factor for the surgeons to chalk out treatment protocol.
- The maximum area, longest diameter, MaAl and MiAL are the features that have been taken to consideration for this decision.

The findings of this literature provides an insight into the significant feature of the tumor to be measured. This information on the measurement of major axis length and minor axis length are derived from the above review. The image pre-processing techniques presented in our work focuses on this feature for the assessment of the condition of the patient undergoing neoadjuvant therapy.

III. ETHODOLOGY

The new methodology proposed in this work aims at providing information to the doctors about the size and features of the tumor to better their evaluation on the type of neoadjuvant therapy to be given to the patient and also monitor the status of the tumor size during the course of the neoadjuvant therapy. The objective of the research work is the analysis of MRI images which reflect the response of the neoadjuvant therapy administered at each successive stage to breast cancer patients in steps.

The block diagram of the proposed method is as shown in Fig
1.

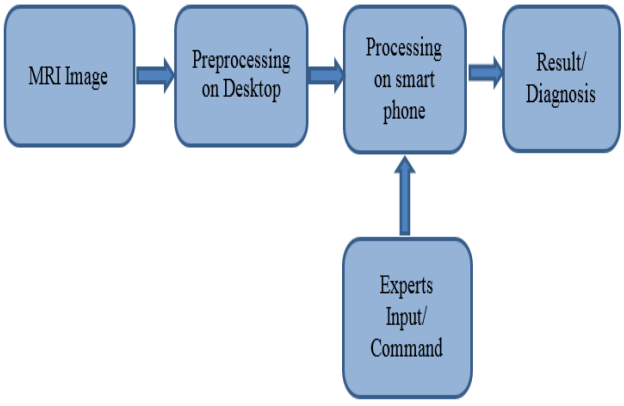

Fig 1: Block diagram of the Diagnostic method.

The proposed procedure involves the following stages:

- Pre-processing
- Segmentation

- Feature Extraction

A. Image Pre-processing

Accurate exploration of the image can be done by subjecting the MRI to pre-processing methods like filtering which removes the noise from the image and provides better quality of the MRI images. Gaussian, imfilter, fspecial, and roi filters are used in this stage of processing as shown in Fig 2 (a), (b) and (c). The result of the pre-processing is that the noise will be reduced and the clear visualization will be obtained by improving the contrast of micro calcifications

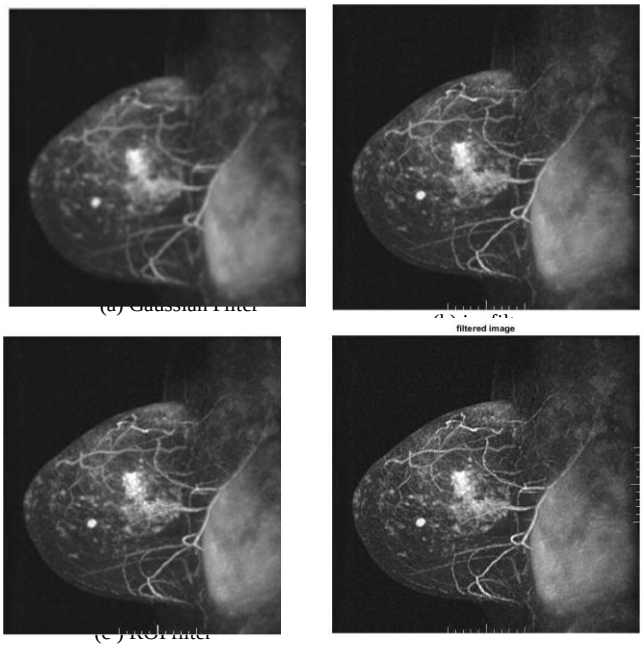

Fig 2: Preprocessing of MRI images by using filter

B. Image Segmentation

The main aim of the segmentation is identification of probable regions of interest Segmentation is carried out to fragment the micro calcifications. Micro calcifications are the irregular masses that appear in the MRI image. The morphological operator used for this purpose is Otsu's thresholding method. The following procedure is adopted in this algorithm

- The micro calcifications which appear as tiny bright spots are filtered with morphological white top hat.
- This will eliminate the contextual noise without diminishing the micro calcifications.
- An ideal threshold is to be fixed to isolate micro calcifications from the background. Otsu's thresholding algorithm will segment the micro calcifications from the image with a very high accuracy.

C. FEATURE EXTRACTION

The methodology adopted in this work aims to develop an image processing diagnostic tool for breast cancer monitoring. There are two parts of this tool, one part is related to acquisition of the images, pre-processing, segmentation and calculation of the features of the image like major axis and minor axis length. The initial stages is pre-processing, which includes using different image filtering techniques like Gaussian filter, fspecial filter, ROI filter to be able to visualize the region of interest. The segmentation of the image is achieved by using Otsu's method as shown in figure 3. The features are extracted from the segmented image.

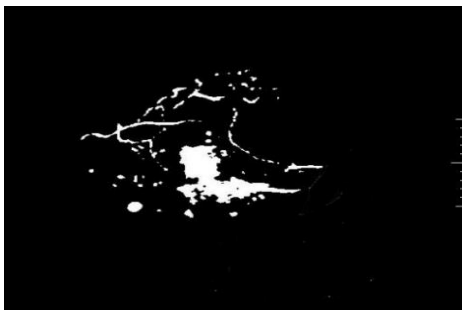

Fig 3: Segmented image

Features like major axis length and minor axis length is determined from the segmented images as a part of the last stage as shown in Fig 4(a) and (b).

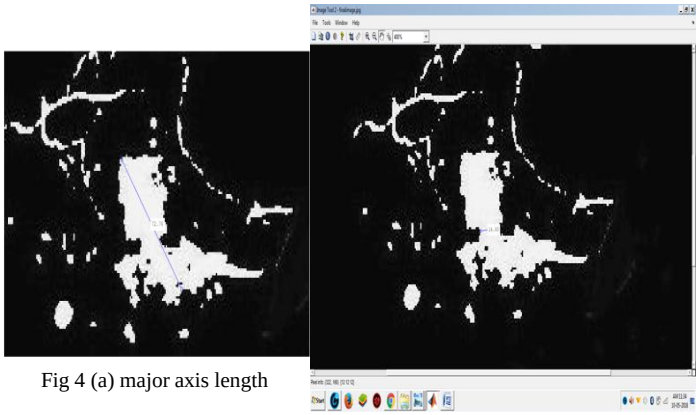

Fig 4 (a) major axis length

The image processing techniques applied on the MRI images are carried out on a desktop with high end software by a pathologist. The Oncologists have to depend on the results observed by the pathologists/ lab technicians for the analysis of the tumor growth/ shrinkage. Smart phone based image visualization technique would provide the oncologists easy

access to the MRI images of the patients and treatment monitoring. This can be achieved by developing a mobile app [6], which provides this provision of viewing MRI images on screen. The next section deals with the development of mobile app RIVA with the help of software Android Studio

An android app named RIVA is developed that actively involves doctors and pathologists in the cancer management process. The MRI images to be diagnosed [7] are transmitted to the smart phone of the oncologists (experts). The processing of tumor is carried out in smart phones instead of desktop. The advantage of transmission is that experts can view the MRI images (same as that of hard copy) and at the same time perform measurement on tumor using the inbuilt in processing capacity of the device [8].

Fig 5: Screenshot of images appearing on the App

IV. RESULTS AND DISCUSSION

The MRI images obtained before and after the neodjuva nt th erapy provides significant information on the status of the tu mor in terms of size, major axis and minor axis length. Th is ai des the physicians to better evaluate and personalize the tre atment course of the patient and also make importa nt de cisions on the type of surgery to be executed. The co mparative analysis of all the filters is illustrated in Table 1. Fs pecial filter is found to provide better PSNR and SNR ratio.

Table 1: Comparitive analysis of Filters

1	Original Image	21.702	10.5805
2	Gaussian Filter	20.216	19.6636
3	IM filter	20.9424	17.1331
4	ROI filter	20.9695	17.0056
5	fspecial filter	20.9893	17.1918

The response of the tumor to the preoperative therapy is indicated as the lengths of the major axis and minor. The decisions on the progressive treatment and breast conservative surgery is made on the basis of the longest diameter measured on the maximum area measured. The treatment measures are determined in accordance with the RECIST criteria. Thus the experimental results show that preoperative breast tumor measurements on MRI provides improved risk stratification methods with better surgical procedure.

V. CONCLUSION AND FUTURE SCOPE

Image preprocessing is carried out on the breast MRI images to determine the major axis length and minor axis length to determine the size of the tumor which provides a valuable information on the type of targeted therapy to be administered to the patients. These details are sent to the smart phone of the physicians by developing an Android app. This provides the doctors and pathologists a common platform for the diagnosis of breast cancer and its prognostification.

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