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# Hybrid UWB Based Imaging Technique for Breast Tumour Detection by using Enhanced Robust and Artifact Removal Algorithm

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***Abstract:*** ***Breast tumour is the high risk disease among women which often causes life threatening fear. In order to recognize the tumour infected breast image UWB imaging technique is utilized. Thus utilized breast image is pre processed for eliminating noise and unnecessary data by Adaptive wiener filter and Recursive least square filter. Henceforth pre processed image is given to FDTD for investigating the breast image for tumour recognition. Thus obtained image given to RAR algorithm for removal artifact from tumour suspected image. Thus obtained image is made auto correlation for brightening the tumour infected areas. Then the breast images are segmented by edge based tumour segmentation and the results are classified with DAS & DMAS algorithm for better accuracy & sensitivity of image.***

***Index Terms – Delay and Sum (DAS), UWB (Ultra Wide Band), Robust and Artifact Resistant algorithm (RAR)***

## I. INTRODUCTION

Analysis of computer aided image has gained a huge interest from medical researchers and signal processors. Owing to its ability to overcome the challenges associated with evaluation of biomedical images. Computer Aided Diagnosis (CAD) has the ability to eliminate wastage of time in evaluating biomedical images. Processing of image is a technique which is able change an image into digital image. And the image is made to undergo few operations to obtain an image with high quality. Processing of image has become a significant area of research as it also provides real time assessment. In human body cells with cancer have a significant role in forming tumour inside the body."Times of India" made a study over three million people living in India is suffering from new forms of Tumour. The most common tumour which affects women widely is breast tumour. Tissues in breast are the complicated part of our body. Hence an accurate analysis and evaluation of tissues is in need for radiologists to recognise the breast tissues with tumour. Breast tumour is an illness which increases the fear of death and makes the life more worried. Breast tumour is susceptible to any aged people. Whereas primary breast tumour are referred as benign and tumour cells with uncontrollable growth are called malignant. The most known types of breast tumours are

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- Ductal tumour- Starts to spread from duct lining. If tumour grows outside of duct it is ductal tumour.
- Lobular tumour- Initially it grows within glands producing milk and spreads in the outside of lobules.
- Paget tumour- Rare form of tumour which grows in glands or inside the breast skin.
- Inflammatory breast tumour – It is an invasive breast tumour which is very rare. It doesn't cause any lump or tumour. It makes the breast skin harder and reddish.
- Triple negative breast cancer – It is a type of tumour in which there is no estrogens and progesterone receptors. It occurs more frequently in younger ones.

Initial diagnosis and intervention are the significant factors for increasing the rate of survival after tumour. At early stages mammography X-ray is the initial imaging technique used for tumour detection. Henceforth the X-ray mammography has sensitivity and specificity limitations. In order to overcome this digital mammography has been utilized and identified to be more effective than X-ray mammography in females below fifties. Uncomfortable compression of breast remains likely in conventional and digital mammography. Henceforth 3D mammography has been developed and it is followed with a number of newly invented techniques for recognition of tumour.

The most commonly utilized techniques are not affordable to all common peoples. These techniques are highly expensive and cause a number of side effects. To eliminate all the above mentioned defects UWB Sensing methodology is used for differentiation of cancerous and non cancerous cells. Thus differentiated images are processed by adaptive wiener filter for noise removal and by Recursive least square filter the unnecessary data in the image is removed. For accurate reflection of contrast dielectrics in between adipose fibro glandular and cancerous tissues in breast FDTD is processed with bit shifting. For identification of tumorous cells RAR algorithm is processed hence the tumours cells are segmented and the results are compared with DAS and DMAS Algorithm.

## II. RELATED WORK

Recognition and classification of breast tumour in the absence of human intervention needs a vast analysis and it includes a multiple number of complications. Many researchers have researched through this area for tumour recognition. In this area numerous works regarding tumour analysis is discussed and evaluated.

Mareo et al [1] proposed a new methodology for UWB applications with tuneable baseband signal. Ifana et al [2] presented a paper F&D fully integrated UWB transmitter which can be utilized by biomedical sensors for low power equipments used in tumour detection. Mahdi et al [3] discussed about Recursive least square filter for increasing the robustness of the tumour recognition method. Elisa et al [4] experimented UWB imaging methodology for tumor identification using DCA based pre-processing methodology. Mirza et al [5] evaluated FDTD models for identification of affected breast cells. Anastasia Baran et al [6] explained a microwave tomography methodology for estimation of tumour from biomedical images for accuracy of tumour recognition region estimation technique is utilized. Sundaram et al [8] analysed the quality of input image and improved the image quality by various filtering techniques for tumour recognition. Tengfei et al [9] evaluated correlation exploration for tumour infected images and differentiated DAS and DMAS. Elahi et al [10] presented radar imaging technique for finding artifact removal in infected images. Arehic blaya et al [11] screened the various tumour infected images and exhibited screening plays the vital role in tumour recognition. Marcela et al [12] proposed an algorithm for denoising image and makes use of filter for further processes. Monica Morrow et al [13] utilized MRI for screening the tumour with good sensitivity. Eheng et al [14] presented a new methodology by utilizing ultrasound images for identification of abnormalities in breast. Computer aided analysis is used for analysing the accuracy of the tumour cells. Hizem et al [15] evaluated the tumorous cell with signal and noise ratio. Maskooki et al [16] utilized artifact removal method for tumour recognition. Klemn et al [17] analysed microwave based radar images for analysis recognition and utilized DAS algorithm for improvisation of image quality and recognize the size of tumour.

## III. PROPOSED WORK

In the developed methodology recognition and differentiation of tumorous breast is done by utilizing Ultra Wide Band (UWB) imaging technique. Thus gained UWB images are pre-processed by utilizing Adaptive wiener filter for denoising the image and Recursive least square filter is used for eliminating unnecessary data in breast image. The input image requires FDTD for electromagnet signal to penetrate into the breast tissues for recognition of tumours. For accurate identification of tumour in the breast tissues a robust and artifact resistant algorithm is developed and UWB image is processed. Thus processed image undergoes auto correlation for brightening the affected areas. Then segmentation is done by edge based segmentation method and then the tumour areas found with high accuracy and the results are compared with DAS & DMAS algorithm for further classification.

## IV. METHODOLOGY

UWB images are the input images which are pre-processed by using two different filters for remove of noise and unwanted data. Hence obtained image is processed by FDTD for penetration of signal into tissues of breast. For tumour identification RAR algorithm is utilized and images are thus brightened by auto correlation and segmented by edge based segmentation with high sensitivity and classified by DAS and DMAS algorithm.

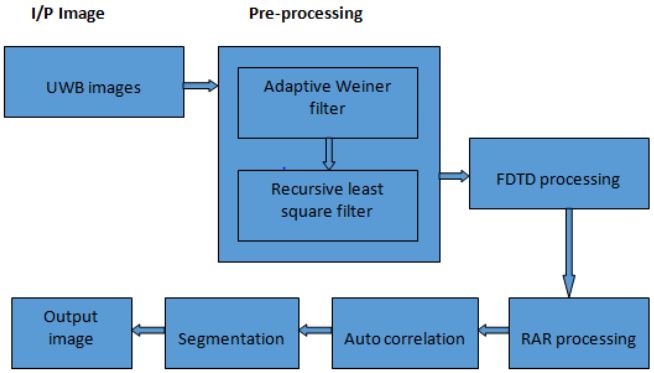


Figure 1 Block diagram of the proposed system

## V. IMAGE PROCESSING

Ultra Wide Band (UWB) is a significant imaging technique which overcomes all the shortcomings of other imaging technique. UWB is capable of achieving maximum data rates up to 1 Gbps. UWB utilizes pulses with minimal power. UWB pulses have highest resolution with multiple paths for tumour detection.

Need for UWB imaging

1. Remarkable differentiation in-between dielectric properties of normal and abnormal breast tissues.
2. Eliminates compression of breasts tissues which is not the cause for tumor.
3. Initial recognition and localization tumor cells in breast.

## VI. PREPROCESSING

In image processing, image acquisition and preprocessing are the elementary need for tumour detection. In this work for preprocessing adaptive wiener filter and Recursive filter is utilized. Adaptive wiener filter is a familiar methodology utilized for enhancement of images. Basic function of adaptive wiener filter is to eliminate the additive noise in the image and to produce a clear image. In preprocessing the size of image is resized and converted to gray to eliminate. Adaptive wiener filter eliminates the additive noise in UWB images of breast. It removes frequent deblurring. Adaptive wiener filter plays a optimum role in minimizing the Mean Square Error (MSE). Filter minimises the total mean square error in inverse filtering and smoothening of noise. The least mean square error point responds to the reduced error power. At this operating point the mean square error surface has zero gradient value and filter weight vector has its optimum value. A signal is completely recoverable from noise when the spectra of the signal and noise don't overlap each other. If the signal and noise occupies different parts of the frequency spectrum, they can be separated by using either low pass or high pass filter. If the signal and noise has overlap spectra, in this case it is not possible to completely separate the signal from noise but the effects of noise can be reduced by using wiener filter.It eliminates the noisy signal and required signal is evaluated by

$$\hat{S}(n) = \sum_{K=0}^{P-1} w_k x(n-K)$$
$$\hat{S}(n) = w^T x$$

Where $x$= input sequence
$S^n(n)$=evaluated output sequence

Thus obtained denoised image from Adaptive wiener filter is fed to Recursive least filter for eliminating unnecessary data in the image. To eliminate the artifact Recursive least square (RSL) filter is utilized.

Signals back scattered constitutes of two types. Initial and final stages Initial stage constitutes incident signals from interface skin fat. In final stage tumour response fatty tissue response are found.

Let $\mu_r$ be the $l * N$ vector with $N$ times of samples with desired signal $r$ and
$u = [u_{r+1} + u_{r+2} + \ldots + u_{r+m}]^T$ is the $M * N$ matrix with processed signals.
$w(n) = [w_{r+1}(n), w_{r+2}(n), \ldots \ldots, w_{r+m}(n)]^T$
Thus the image is processed by eliminating unwanted noise and data is fed to FDTD processing.

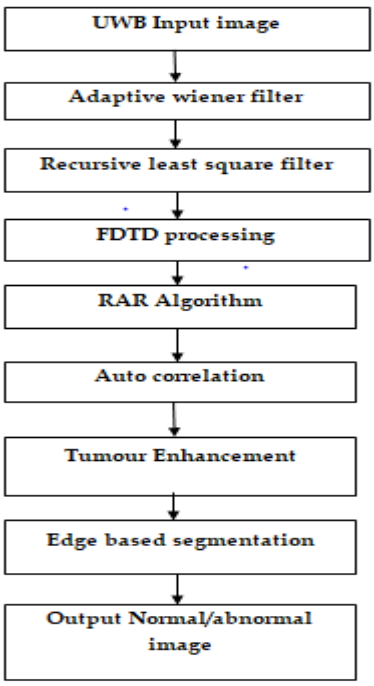


Figure 2 Flowchart of proposed system

## VII. FREQUENCY DOMAIN/TIME DOMAIN PROCESSING (FDTD)

Each and every imaging technique needs high accuracy in breast images for scattering and penetration of UWB signals within the breast. The methodology of frequency domain & time domain is a numerical method for execution of electromagnetic (EM) signals into the tissues of breast. This EM signal develops heat in the breast tissues [18]. The quantity of temperature increase with respect to exposure restriction to fields in between 100 $KHz$ and 10 $GHz$ is the specific energy absorption rate [20].

$$SAR = \frac{\sigma |E|^2}{\rho}$$

$\rho$=density
σ = conductivity

The FDTD methodology presents a direct solution of coupled time dependent Maxwell curl equations.

$$\nabla XH = \sigma E + \in \partial E/\partial t$$
$$\nabla XE = -\mu \partial H/\partial t$$

Where E=electric field
H= Magnetic field
σ= electrical conductivity
c= permittivity
μ= permeability

Thus the permittivity, permeability and sensitivity of image are improved by this technique. Thus processed UWB breast images from FDTD id fed to the RAR algorithms for recognition tumour.

## VIII. ROBUST AND ARTIFACT RESISTANT (RAR) ALGORITHM

In the developed work a novel shortcut and Artifact Resistant Algorithm is proposed to recognition of tumour with high accuracy. In the beginning the layer of skin is the first scattered in which EM signal constitutes large magnitude thus backscattering is stronger than latter time response [19]. Next, skin has large permittivity than fatty tissues. Henceforth diminutions of artifact signals have to be done. Realizations of initial stage artifact have to be ideally eliminated with respect to prior information regulated from normal breast images. The $i$ th transceiver from ideal tumour response in discrete form exhibited as

$$Si(n) = S_{i\_with\_tumor}(n) - S_{i\_tumor\_free}(n)$$

Where $n = 1,2, \ldots, K$

$S_{i\_with\_tumor}(n)$ = backscattered signal received at $i$th transceiver from tumour $S_{i\_tumor\_free}(n)$ = backscattered signal received at same transceiver from breast model without tumour

Elimination of artifact have to be achieved if not, the tumour intensity and size cannot be recognized. Hence RAR algorithm is developed for evaluating the intensity of all the pixels. Let $l$ denote the $l$ th location of pixel in the image. For all the location correlation between time shifted signals gets exploited by RAR. Hence time shifted signal have maximum correlation in between response of tumour cells.

For evaluating the intensity values of $l$ the following steps are evaluated.

Step 1: With respect to corresponding time delay at $l$ all pre-processed $Si(n)$ is time shifted. Signal time shifted are exhibited as $S_i(n + \tau_{il})$

Antenna number is denoted as $A$. After eliminating artifact signal with tumor is gathered. Henceforth for each location $l$ there are time delays with $A$ set with respect to transceiver. Let $sum_1(n)$ $(n = 1,2, \ldots \ldots, k)$ represent every signal with time shift.

$$Sum_{1(n)} = \sum_{i=1}^{A} S_i(n + \tau_{il})$$

Step 2: Tumour response is increased and adverse effects resulted at initial and final stages artifact, a weight factor $wf_1$ for $l$ th location is given. The coefficient for Pearsons correlation is evaluated as

$$r_{ij-l} = \frac{\sum_{n=1}^{\infty} X_i(n)X_j(n)}{\sqrt{(\sum_{n=1}^{\infty} X_i(n)^2 \sum_{n=1}^{\infty} X_j(n)^2)}}$$

Where $X_i(n) = S_i(n + \tau_{il})$

$X_j(n) = S_j(n + \tau_{il})$

$j = i + 1$

Step 3: For evaluating the $l$ th location intensity Additionally aligned time signals don't respond to location of tumor in complex medium. The sum has high value at location of tumor. The constituted signal $c_1(n)$ is

$$C_1(n) = wf_1.Sum_1(n)$$

For all the location the above steps are repeated inside the region of image.

$$I_l = \sum_{n=1}^{\infty} [C_1(n)]^2$$

Thus the Artifact is removed by utilizing RAR algorithm from breast image with tumor.

**Auto correlation**

For enhancing or brightening a specific area in a UWB image Auto correlation is performed with the tumorous image itself as a function offset or log.

Auto correlation is represented by Fourier transforms

$$f(x,y) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} f(x^1,y^1).f(x+x^1,y + y^1)\, dx^1\, dy^1$$

Where $f(x,y)$ = function which brightens image

Thus obtained brightened image of breast tumor cells are fed to enhancement of image by eliminating the artifact and the image is enhanced.

**Edge based segmentation**

Segmentation is a process subdividing an image into regions. In this work edge based segmentation is utilized for recognition of tumour in breast image with high accuracy. The unwanted pixel in the edge of the image is segmented with the high intensity. Thus enhanced image is segmented with tumor recognition.

## IX. RESULTS

The developed work is presented on matlab software toolbox with 4Gb RAM. For evaluating the proposed work eight input UWB images are utilized for calculating the intensity of tumour. The input images are analyzed by various steps. It includes pre-processing, Frequency Domain/ Time Domain processing, RAR algorithm, Tumour enhancement, segmentation and classification of tumour images. In pre-processing adaptive wiener filter and recursive filter for removal of unnecessary noise and data in the UWB breast image. Then the image is fed to FDTD[20] and artefact removal.In this section performance of the RAR algorithm is evaluated for recognition of tumor images. Thus obtained breast image with tumor is evaluated by differentiating the tumor image with DAS, DMAS. By utilizing DAS and DMAS the tumour infected breast image is classified with conductivity, specificity.

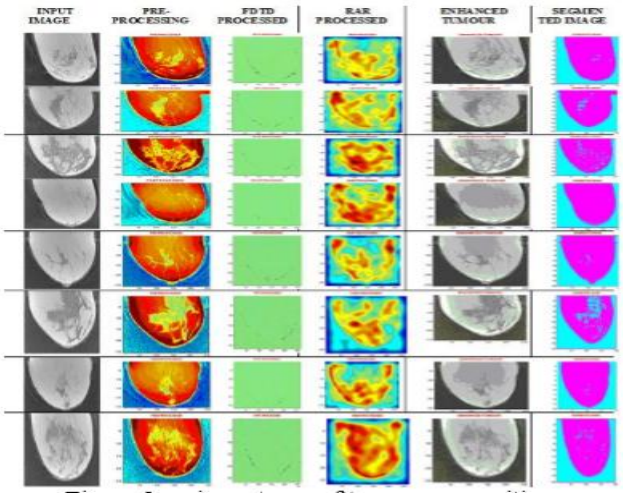


**Figure 3 various stages of tumour recognition**

Delay and sum (DAS) is a familiar methodology. After segmentation the exact time delays are calculated for all the signals received. For calculation of the time delay of transmitting & receiving antenna the position of antenna is analyzed.

In all the location every shifted time response are summed and integrated. Windowed signal performs integration. Integration window length is chosen with respect to bandwidth of the system.

$$F_e(x,y,z) = \int_0^{\tau} \sum_{i-1}^{M} w_i(x,y,z).y_i\big(t - T_i(x,y,z)\big)^2 dt$$

Where $M = \frac{N(N+1)}{2}$

$T_i$ = Time delay

$y_i$ = Radar signal

$\tau$ = Integration window length

In DMAS algorithm all the image points calculates time delay for all array elements are linked and multiplied and the similarity is calculated. DMAS is developed to overcome the shortcomings of DAS algorithm. As DAS has minimal resolution of breast images and contributes highly to off axis signals. Thus the segmented breast images are evaluated by DAS and DMAS whereas DMAS provides tumour recognition and classification with high accuracy and performance.

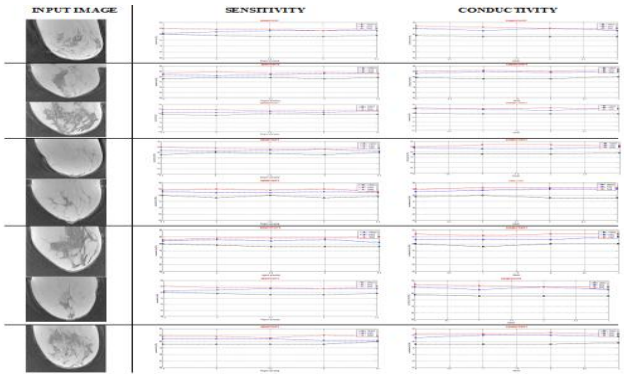


**Figure 4 Representation of specificity and conductivity of tumour images**

The above figure4 shows the input images with tumour and the tumour infected images are differentiated by evaluating the specificity and conductivity of the images. These factors are evaluated by utilizing the DAS, DMAS and RAR algorithm. Thus classified breast images are exhibited in the figure. From the above figure it is observed that the DMAS outperforms the DAS and RAR and produces tumour infected image with high accuracy and sensitivity.

## X. CONCLUSION

The developed method for recognition of breast tumour is alone through UWB imaging technique. This work develops a unique methodology whereas the UWB image is pre processed using Adaptive wiener filter for noise removal and Recursive least square filter for eliminating unnecessary data. Thus pre processed image is fed to FDTD for frequency & time domain for tumour response. Thus obtained images are processed with RAR algorithm in which backscattered images are time shifted, weighted and summed. These summed images are segmented by edge based tumour recognition for breast tumour identification. The segmented images are auto correlated for brightening tumour area and enhanced for further classification using DAS & DMAS. Whereas DMAS fed tumour images have high accuracy and sensitivity.

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