Differentiation of Breast Lesion in Digital Breast Tomosynthesis (DBT) By Using Digital Image Processing

Niroshani HS[*], Wansapura JP[**], Senanayake G[***]

[*]Department of Radiography & Radiotherapy,Faculty of Allied Health Sciences,General Sir John Kotelawala Defence University,Sri Lanka
[**] Department of Physics,Faculty of Science,University of Colombo,Sri Lanka
[***] Department of Pre-clinical Sciences,Faculty of Medicine, General Sir John Kotelawala Defence University,Sri Lanka

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Abstract- Aim of this study was to differentiate the benign and malignant tumors according to the density values within the tumors. This study was based on the preprocessed mammograms obtained from the DBT machine and to calculate the density value by using mathlab. Effects of breast thickness and age of the patient also considered. Craniocuaded (CC) and Mediolateral Oblique (MLO) views of Mammograms were collected by using data base of Digital Breast Tomosynthesis system. Already reported 48 images were collected and assess the density of the tumor by measuring of pixel values within the benign and malignant lesion.customized MATLAB programme. According to the quantitative analysis there was a significance difference between mean pixel value of the tumor in both CC and MLO views among benign and malignant group ($P<0.05$). And it was evident there was a strong positive linear regression between Pixel value of the tumor and the age of the patient. But there was no significant relationship between pixel value of the tumor, and the thickness of the breast in both views. Study was concluded that the pixel value of the tumor can be used to differentiate benign and malignant breast tumors. According to the discriminant analysis sensitivity was less in CC than MLO images. Therefore less percentage of false negative was reported in MLO view images. Specificity was high in both CC and MLO view images. Therefore few percentage of false positive was reported.

Index Terms- Mammography, Digital breast tomosynthesis, Pixel value

I. INTRODUCTION

Digital Breast Tomosynthesis (DBT) also known as 3-Dimensional (3-D) is recent technical improvement in mammography. Digital breast tomosynthesis aids the early detection and accurate diagnosis of breast diseases[1].Conventional mammography examination is 2-dimensional and two x-ray images are taken of the breast. In mammography breast is compressed in order to produce breast images. But it may cause overlapping of the breast tissue. Therefore abnormal tissue can be hidden[2] . Tomosynthesis producing the images by moving x-ray tube in an arc over thecompressed breast and captured multiple 3-D images as well as 2-dimensional fulfilled digital images (2-D FFDM).These 3-D images clearly distinguish the normal breast tissues from the abnormal breast tissue[3].

Breast masses mainly categorized in to benign and malignant. Mammogramms clearly reveal breast lesions which may not be clinically palpable. Breast mass has a volume & it occupies space within the breast. The tissues within the breast mass different from the other areas of the breast[4] . Most of breast tumors are benign such as fibrocystic changes, fibroadenoma, papilloma. Malignant breast tumors having different characteristics from benign tumors.These malignant tumors should be detected and treated early to avoid the metastasis[5].

An accurate diagnosis of breast lesions is required for optimal treatment Mammography has become important in breast imaging up to date. But not all the cancers can be detected by Mammography[6].There are some factors which lower the sensitivity of Mammogram include technical & interpretative errors,rapid tumor growth patterns and extensive mammographic breast density.Hence it will obscure the lesion detection[3]. Breast density changes with the age of the women and other reason such as hormone replacement therapy (HRT). Mammographic density is higher among younger, premenopausal women.

As a clinical imaging modality DBT improve the detection of breast lesions in women with dense breast. It enables the acquisition of three dimensional images(3D-images) of the breast and it creates sequential thin images through breast[7].DBT overcomes the limitations caused by overlapping tissues during standard two dimensional imaging(2D-Imaging)in conventional mammography. It is allowing the visualization of breast lesions which are not appears in 2D conventional mammography[2].

DBT gives potential advantage of evaluation of masses and other pathologies associated with breast with its advanced technology compared to 2D conventional mammography. Therefore in this study, evaluating the lesion morphology on DBT to distinguish between malignant and benign tumors of the breast by using digital image processing[8].

II. JUSTIFICATION

Breast cancer is currently considered the most common cancer among women.Early and accurate diagnosis may benefit to provide successful treatment for the patient.In all over the world mammography plays a major role in screening of breast cancer as it detects breast cancers at their early stage.But mammography show low sensitivity when patient is having dense breast. Digital breast tomosynthesis overcomes the limitations occurred with conventional mammography and improve the detection of breast lesions in women with dense breast.
Density is the one of the main feature of differentiation of malignant and benign lesions. In this study, mainly measure the density values within the lesion quantitatively. In order to suggest a range of density value for malignant and benign lesion respectively.

III. RESULTS

The study sample was included DBT images from 48 patients. Data was collected through machine storage with no inconvenience to hospital setup.DBT images of Patients who have already diagnosed as malignant and benign lesion.
Images were stored in MATLAB and display as grayscale image. All the images were preprocessed for visual enhancement. Measurement of pixel values within the benign and malignant lesion was taken from the customized MATLAB application
According to the developed MATLAB programme in this study I have removed the pectoral major muscle and prominent blood vessels within the breast area.
A whole breast area was selected to get the pixel value of normal breast tissue. Pectoral major muscle, prominent blood vessels and tumor area was excluded from the normal breast area. The tumor outline was selected separately. A pixel value was taken for normal breast area and tumor with the help of MATLAB programme. The ratio of the pixel values were taken between tumor and the breast area.

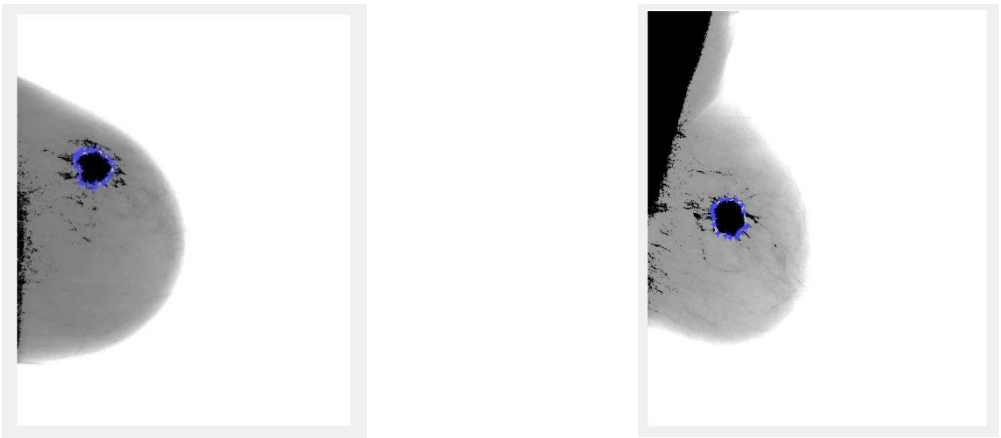

Figure 1: *CC& MLO view images with selected tumor*

Out of total sample of 48 of patients,there were 28 benign tumor images and 20 malignant tumors.

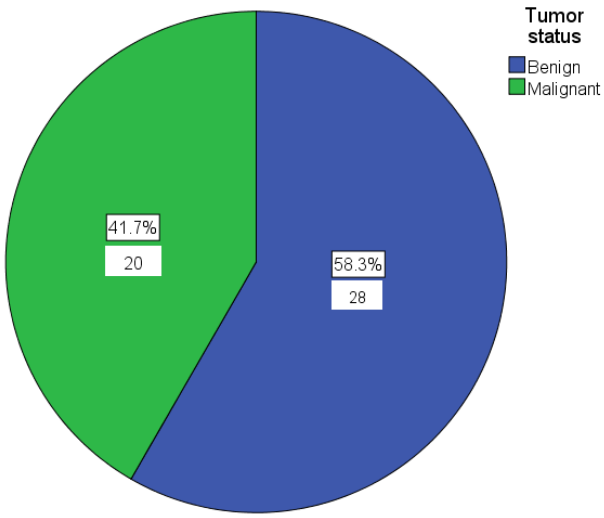

Figure 2: Distribution of tumor status of total sample population

Table 1: Descriptive statistics of the explanatory variables: Craniocauded view

	N	Range	Minimum	Maximum	Mean	Std. Deviation
pixel value of the tumor	48	2234.08	1249.28	3483.36	2458.53	412.13
pixel value of the breast	48	566.88	742.65	1309.54	1071.30	137.56
ratio of the pixel value	48	2.59	1.04	3.64	2.34	0.52
Thickness (mm)	48	54.00	25.00	79.00	42.69	10.68
Force	48	26.70	14.30	41.00	26.78	6.02
kVp	48	5.00	26.00	31.00	27.88	1.24
mAs	48	314.00	56.00	370.00	178.56	82.87
Age	48	48.00	28.00	76.00	54.92	10.64

Table 2: Descriptive statistics of the pixel value and the pixel value ratio of the benign and malignant tumors: CC view

	Conditions					
	Benign group			Malignant Group		
	Mean ± SD	(Min- Max)	Range	Mean ± SD	(Min- Max)	Range
Pixel value	2344.28 ±451.71	1249.28 - 3483.36	2234.08	2618.33 ±290.03	2067.49 - 2985.27	917.78
Ratio of the pixel value	2.24 ±.55	1.04 - 3.04	1.99	2.48 ±.45	1.83 - 3.64	1.8

Table 3: Summary of independent t-test-CC view

	t-test for equality of means						
	t	df	Sig.(2-tailed)	Mean difference	Std.error difference	95% confidence interval of the difference	
						Lower	Upper
Pixel value of the tumor	-2.380	46	0.021	-273.950	115.080	-505.609	-42.303
Ratio of the pixel value	-1.587	46	0.119	-.238	0.150	-0.540	0.064

Mean pixel value of the tumor in benign group was 2344.38 and range was 2234.08. Mean pixel value of the tumor in malignant group was 2618.33 and range was 917.78 (table 2). Mean value of the tumor in malignant group was higher than that of the benign group.
Since P value was 0.021 for the pixel value of the tumor ($P<0.05$) which indicate there was significant difference in pixel value of the tumor between benign and malignant group for CC view.
When compared ratio of the pixel value in benign and malignant group P value was 0.119 ($P>0.05$) which indicate there was no significant difference of ratio of the pixel value between benign and malignant group for CC view.
Below scatter plots were created to see the distribution of pixel value of the tumor and pixel value ratio of the tumor with age of the patient and thickness of the breast in CC view.

Table 4: *Descriptive statistics of the explanatory variables: MLO view*

	N	Range	Minimum	Maximum	Mean	Std. Deviation
pixel value of the tumor	48	1904.87	1288.48	3193.35	2424.64	400.56
pixel value of the breast	48	475.51	889.92	1365.43	1093.27	119.61
ratio of the pixel value	48	1.93	1.26	3.19	2.24	0.46
Thickness (mm)	48	52.00	35.00	87.00	53.96	10.45
Force	48	22.9	17.0	39.9	28.90	5.92
kVp	48	8.00	25.00	33.00	29.46	1.79
mAs	48	378.00	81.00	459.00	264.88	121.19
Age	48	48.00	28.00	76.00	54.92	10.64

Table 5: *Descriptive statistics of the pixel value and the pixel value ratio of the benign and malignant tumors: MLO view*

	Conditions					
	Benign group			Malignant Group		
	Mean ± SD	(Min- Max)	Range	Mean ± SD	(Min- Max)	Range
Pixel value	2322.21 ±80.58	1288.48 - 3125.84	1837.36	2568.05 ±71.21	2102.77 – 3193.35	1090.58
Ratio of the pixel value	2.21 ±.09	1.26 - 3.19	1.93	2.28 ±.08	1.68 - 3.14	1.45

Table 6: *Summary of independent t-test-MLO view*

	t-test for equality of means						
	t	df	Sig.(2-tailed)	Mean difference	Std.error difference	95% confidence interval of the difference	
						Lower	Upper
Pixel value of the tumor	-2.178	46	0.035	-245.84	112.86	-473.028	-18.659

Ratio of the pixel value (Equal variances not assumed)	-0.554	45.989	0.582	-0.071	0.128	-0.330	0.187

Mean pixel value of the tumor in benign group was 2322.21 and range was 1837.36.Mean pixel value of the tumor in malignant group was 2568.05 and range was 1090.58. (table 5) Mean value of the tumor in malignant group was higher than that of the benign group.
Since P value was 0.035 for the pixel value of the tumor ($P<0.05$) which indicate there was significant difference in pixel value of the tumor between benign and malignant group for MLO view.
When compared ratio of the pixel value in benign and malignant group P value was 0.582 ($P>0.05$) which indicate there was no significant difference of ratio of the pixel value between benign and malignant group for MLO view.

Table 7: *Classification results-CC view*

Original	Tumor status	Predicted group membership		Total
		Benign	Malignant	
Count	Benign	22	6	28
	Malignant	11	9	20
%	Benign	78.6	21.4	100.0
	Malignant	55.0	45.0	100.0

According to the classification results sensitivity was 45.0% and specificity was 78.6% for CC view

Table 8: *Classification results for MLO view*

Original	Tumor status	Predicted group membership		Total
		Benign	Malignant	
Count	Benign	22	6	28
	Malignant	9	11	20
%	Benign	78.6	21.4	100.0
	Malignant	45.0	55.0	100.0

According to the classification results sensitivity was 55.0% and specificity was 78.6% for MLO view.

IV. CONCLUSION

The study concluded that quantitative analysis of the pixel value of the tumor is a reliable technique for differential diagnosis of benign and malignant tumor while ratio of the pixel value between tumor and normal breast area not improve the diagnostic performance.
This quantitative measuring of pixel value within the tumor can be used to confirm the radiologist's decision when difficult to diagnose the patient's tumor condition.
Sensitivity was less in CC than MLO images. Therefore less percentage of false negative was reported in MLO view images. Specificity was high in both CC and MLO view images. Therefore few percentage of false positive was reported.

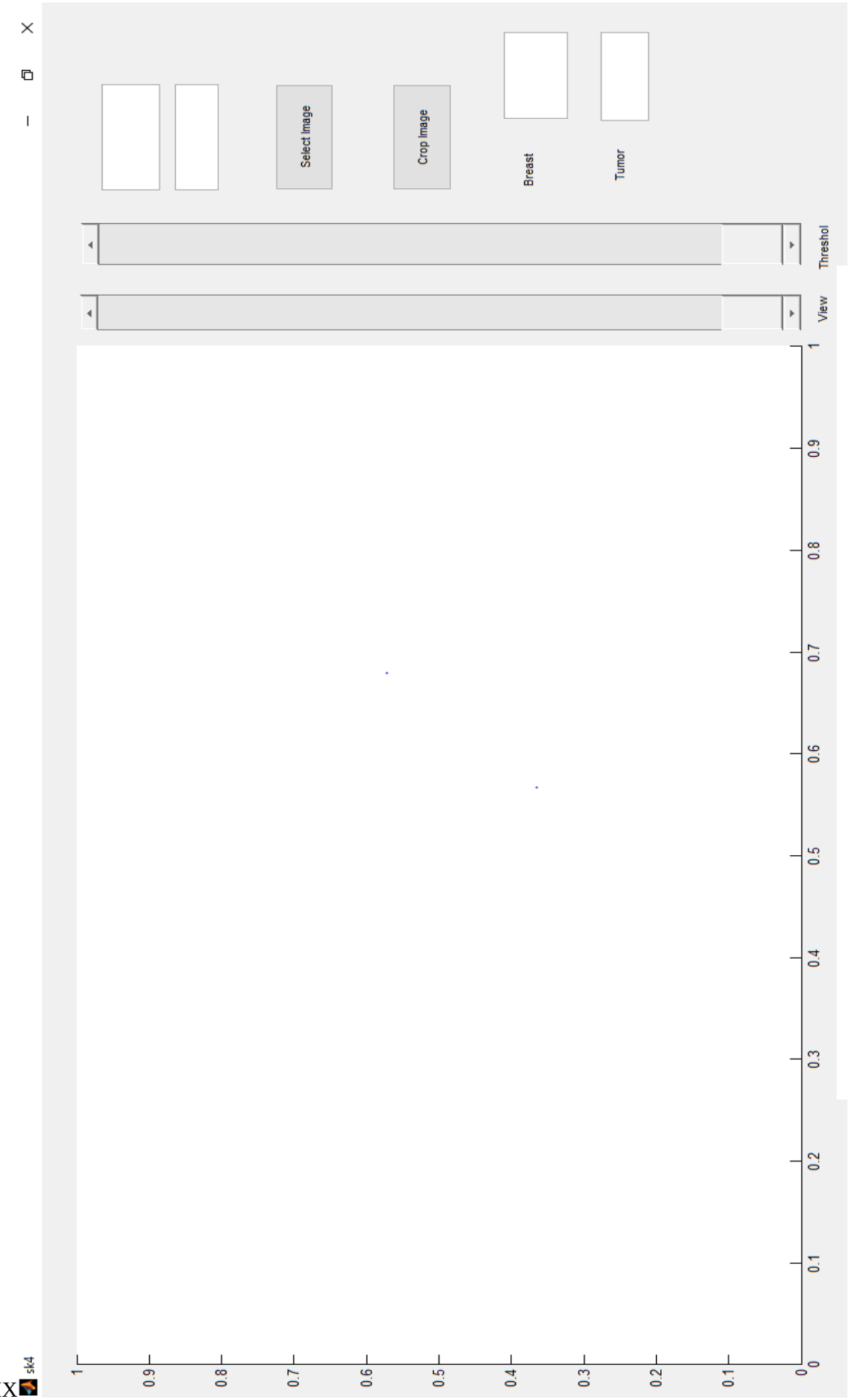

Figure 3: *Customized MATLAB application to obtain pixel value*

V. APPENDIX

VI. ACKNOWLEDGMENT

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AUTHORS

First Author – HS Niroshani, BSc,MSc,Department of Radiography & Radiotherapy,Faculty of Allied Health Sciences,General Sir John Kotelawala Defence University,Sri Lanka, sach06025@gmail.com.
Second Author – JP Wansapura, BSc,PhD,Department of Physics,Faculty of Science,University of Colombo,Sri Lanka janaka.wansapura@phys.cmb.ac.lk
Third Author – G.Senanayake,MBBS,MD, Department of Pre-clinical Sciences,Faculty of Medicine, General Sir John Kotelawala Defence University,Sri Lankam gayanisenanayake@hotmail.com

Correspondence Author – HS Niroshani, sach06025@gmail.com. +940715283250