DETECTION OF LINEAR STRUCTURES IN MAMMOGRAM

D.Ravikumar 1, V.Devi 2, M.Monisha 3, P.Vijayalakshmi 4, E.N.Ganesh 5

1, 3, 4 Assistant Professor, Department of Electronics & Communication Engineering, Vels Institute of Science, Technology & Advanced Studies

2 Associate professor & Head, Department of Computer Applications,

Gurunanak College, Chennai.

5 Dean, School of Engg, Vels Institute of Science, Technology & Advanced Studies

E-mail: ravi.se@velsuniv.ac.in, enganesh50@gmail.com

ABSTRACT

Recently, there has been interest in the proportion and distribution of parenchymal linear structures in the breast. The proportion of linear structures has been linked to mammographic risk. Three–dimensional tomosynthesis represents a significant advancement over conventional two– dimensional mammography, effectively eliminating many of the inherent problems caused by representing the 3D anatomy in a 2D image. Results show a high degree of correlation (0.866) between the proportions of linear structures detected in the two image types. This experiment investigates the proportion of linear structures detected in raw tomosynthesis images and compares them to the proportion detected in corresponding conventional mammograms of the same patient taken at the same time

Keywords: Mammogram, Breast Cancer, Tomosynthesis image, Linear Structure.

1. INTRODUCTION

In conventional methods 2D projection mammography play a vital part in detection of breast cancer, diagnosis and treatment. There are several intrinsic restrictions in 2D, affected by the projection of three dimensional breast anatomy on to a two dimensional plane. The cancers being unknown by superimposed normal tissue and intersecting normal tissue generating the artificial look of densities [1]. These constrain delivers result in false–positive or false–negative diagnoses, rising threat to the patient or revealing them to needless. Whereas a lot of these limits could be overcome by magnetic resonance imaging (MRI), this is a far more complicated procedure and its high cost, low availability and inconvenience avoid the use of MRI from becoming wide range for the detection of breast cancer. 3D breast tomosynthesis delivers a key improvement over projection mammography. Tomosynthesis eliminate the effects of superimposed tissue on parenchymal structure of interest more efficiently [2, 3]. This can increase margin visibility, specifically in dense breasts and has been shown to raise lesion visibility [4]. Breast tomosynthesis achieves a series of projection x–ray images as the x–ray source transfers in an arc around the static breast and digital imaging detector. With the elimination of their acquisition angle, the 'raw' projection images are linked to conventional x–ray mammograms, however they are taken using a significantly lower x–ray dose than that using for conventional mammograms, such that the complete dose received by the patient is like for the two methods [4]. The raw projection images are subsequently reconstructed in to a three–dimensional volume that can be displayed to a radiologist. Many algorithms have been used in the reconstruction of tomosynthesis images, common examples include filtered back projection and shift–and–add. In this experiment the raw tomosynthesis images are used rather than three–dimensional reconstructed images since a more straightforward and continuous calculation can be made between them and corresponding conventional mammograms. Linear structure data in mammograms has been linked to mammographic risk and identified linear structure data has shown capacity in increasing the specificity of automatic risk assessment [6, 9, 12]. To calculate the pattern of breast carcinoma and therapeutic regimen provided to the patients and to estimate the epidemiological profile of the disease, the risk factors related with them, and the treatment provided to these cancer patients are determined in [15].

2. Linear Structures

Mammographic risk assessment is concerned with valuing the probability of women developing breast cancer and can deliver a sign of when to recommend regular screening, which has been presented to develop the likelihood of the initial judging of breast cancer [5]. Breast density is a main display of mammographic risk [6] and the best predictor of mammographic sensitivity [7].

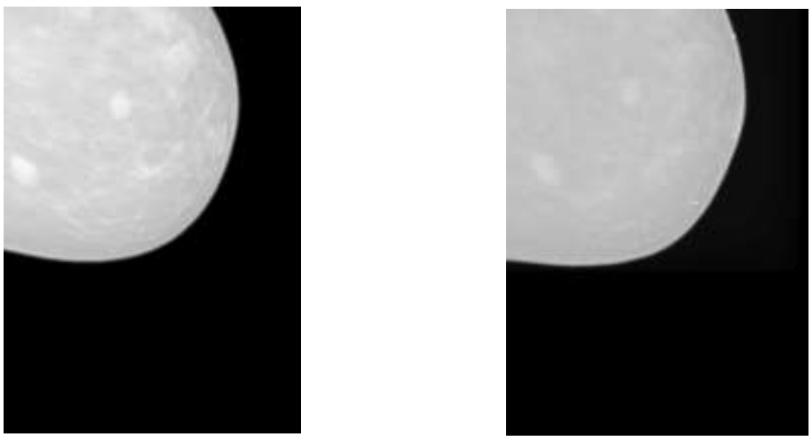


Figure1. Linear structure of conventional mammogram (left) and a corresponding raw tomosynthesis image (right).

It has been suggested that the distribution of linear structures (ducts, blood vessels, etc.) is also linked with mammographic risk [8,9]. So far it is not completely clear if it is just the density of linear structures (either by percentage area or volume) or if the distribution of the linear structures plays a part as well. The mammographic risk assessment representation based on four structural components, where the relative proportions of each component is linked to the risk of developing breast cancer [8–10]. One of the four structural components is linear density. It has been shown that the proportion of linear structures in the breast can be used to automatically guess mammographic risk [11, 12]. The main aim of this research work is to examine the sensitivity of the finding of linear structures in tomosynthesis images equated to corresponding conventional mammograms images.

3. METHODS

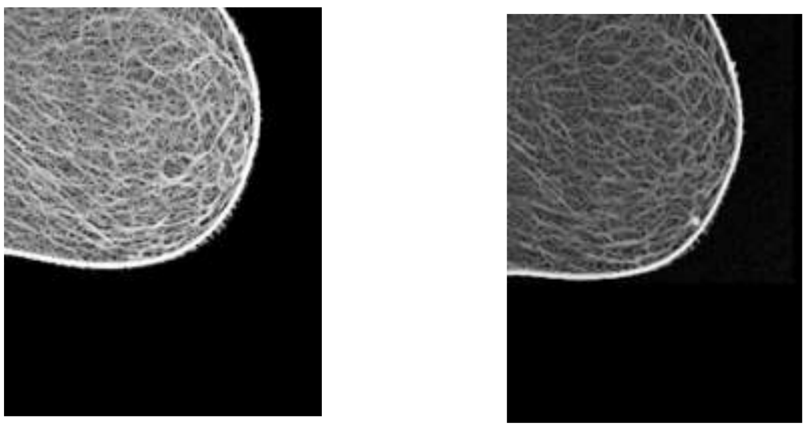
In this paper the experimental results was carried out from 40 patients. The images are taken from the patients on a particular day which comprises two conventional mammograms referred with (left and right breast) and 2 sets of nine raw tomosynthesis images. From the sets of nine raw tomosynthesis images, the middle image indicates an orthogonal vision and related nearly with the MLO conventional mammograms, and as such these middle images were selected for result confirmation. The images were signified as 12–bit grey scale, 1914x2294 pixel DICOM files. The resulting 80 conventional mammograms and 80 raw tomosynthesis images were processed using the line detector method (described below), which results in a measure of line strength and orientation for each pixel in the breast area of the image. Finally, for each image the line strength values were thresholded and the proportion of pixels with above–threshold line strength values in the breast area of the image was calculated.

Line Operator

The Dixon and Taylor’s line operator [14] will detect linear structures in mammograms more accurately than other methods mentioned by various studies [13]. We used line operator which generates a measure of line strength and orientation for individual pixel in an image for verifying the experimental results, the line orientation is calculated by the mean pixel illumination of a line of pixels running through the identified pixel at a collection of particular point. The particular point with the maximum mean illumination is engaged to be the line orientation. The line strength, X, is obtained by

$$X = (Y - M) \quad \text{-------------------------------------} \quad (1)$$

where Y is the mean illumination of the line of pixels, and M is the mean illumination of a correspondingly orientated square of pixels. A line length of 5 pixels and 12 orientations was used for experimental result verification as prescribed by previous research in [13]. A different scale approach was implemented in order to find out the lines of a range of thicknesses and the resultant images were link to generate line strength data for pixels at the new scale. Scaling of the images was attained initially by blurring the image using a 3x3 Gaussian kernel and later by subsampling to deliver a resultant image of half the width and height of the new. In this research proposed the comprised processing with the line operator at three scales.



.Figure 2. Conventional mammogram image (left) and a corresponding raw tomosynthesis (right).

Thresholding

The results of line strength were thresholded to eliminate background tissue, which aims to left only linear structures. The measure of proportion of linear structures will be affected by choice of thresholds. The thresholds were chosen experimentally to select values that remove most background tissue whilst leaving most of the linear structure information complete. For these experiment threshold values of 0.4% and 0.5% was used. The thresholds were applied by normalizing the line strength values between 0 and 4096 (the maximum grey scale value for the images used), and then by removing all line strength values below the specified proportion. In the cases used, all line strength values below 0.4% or 0.5% of 4096 were removed. The overwhelming majority of line strength values in the images were considerably below the maximum theoretical value. As such, the threshold values used were very small so as not to remove too much linear structure information.

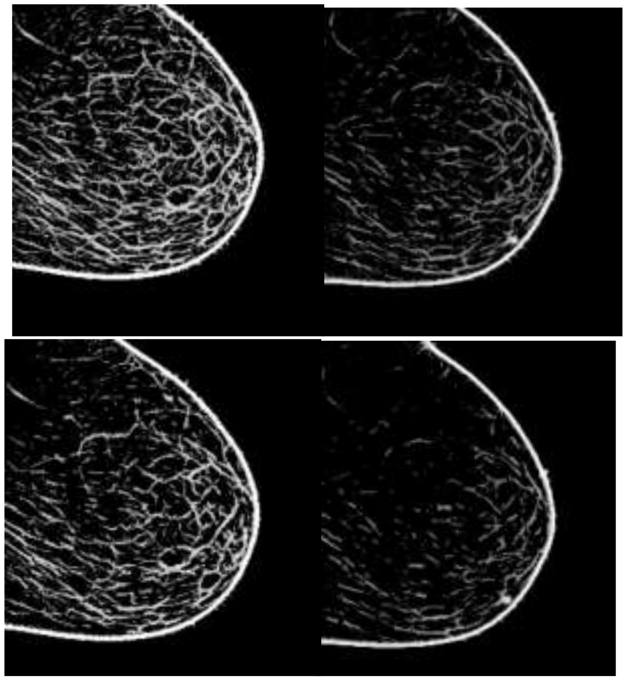


Figure3. Line operator results thresholded at 0.4% and 0.5%.

RESULTS

The Fig. 4 shows the proportion of above–threshold linearity in raw tomosynthesis images adjacent to the equivalent conventional mammograms. A threshold of 0.5% was used in both the conventional mammograms and tomosynthesis images in demand to attain the best correlation. This achieved a Pearson product moment correlation coefficient of 0.866.

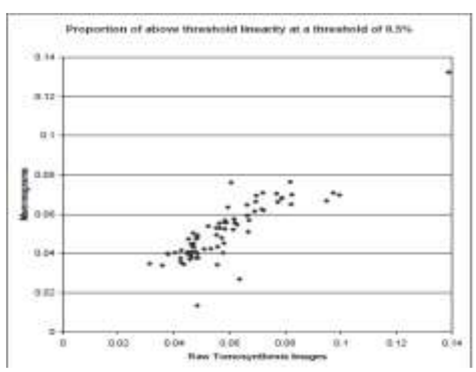


Figure 4. A proportion of raw tomosynthesis images at a threshold of 0.5%.

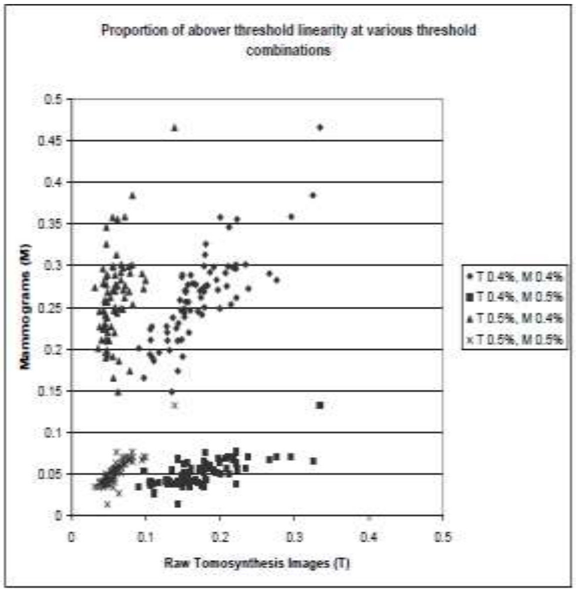


Figure 5. A proportion of raw tomosynthesis images at different variety of thresholds.

CONCLUSIONS

The results in Fig. 4 show that raw tomosynthesis images have more relationship between the identified quantities of linear structures when related with conventional mammograms (0.866). The information available in linear structure raw tomosynthesis images can be suggested for mammographic risk evaluation examinations. For different types of images the contrast will vary, to achieve closest correlation the thresholds were selected independently. However the relationships were more when both raw tomosynthesis images and conventional mammograms were thresholded at 0.5% (0.866) and when both were thresholded at 0.4% (0.813). The selected threshold will affect the correlations. When mammograms thresholded at 0.5 % and tomosynthesis images thresholded at 0.4% (0.714) are compared the relationship remains worthy, however when these thresholds were reversed (0.475), the correlation was less sensitive. An obvious subsequent investigation would involve attempting to automatically classify images in to BIRADS classes based on the linear structure information in the tomosynthesis images. However, this would require that the images be classified independently by a radiologist, and for clear results, a larger sample size would be beneficial.

References

1. P. T. Huynh, A. M. Jarolimek & S. Daye. "The false-negative mammogram." Radiographics 18(5), pp. 1137–1154, 1998.

2. J. T. Dobbins & D. J. Godfrey. "Digital x–ray tomosynthesis: current state of the art and clinical potential." Physics in Medicine and Biology 48(19), pp. R65–106, 2003.

3. M. Varjonen. "Three–dimensional digital breast tomosynthesis in the early diagnosis and detection of breast cancer." Lecture Notes in Computer Science 4046, pp. 152–159, 2006.

4. L. T. Nikalason, B. T. Christian, L. E. Nikalason et al. "Digital tomosynthesis in breast imaging." Radiology 205, pp. 399–406,1997.

5. C. H. van Gils, J. D. Otten, J. H. Hendriks et al. "High mammographic breast density and its implications for the early detection of breast cancer." Journal of Medical Screening 6, pp. 200–204, 1999.

6. J. N.Wolfe. “Risk for breast cancer development determined by mammographic parenchymal pattern.” Cancer 37(5), pp. 2486–2492, 1976.

7. T. M. Kolb, J. Lichy & J. H. Newhouse. “Comparison of the performance of screening mammography, physical examination, and breast us and evaluation of factors that influence them: An analysis of 27,825 patient evaluations.” Radiology 225(1), pp. 165–175, 2002.

8. I. T. Gram, E. Funkhouser & L. Tab´ar. “The Tab´ar classification of mammographic parenchymal patterns.” European Journal of Radiology 24(2), pp. 131–136, 1997.

9. L. Tab´ar, T. Tot & P. B. Dean. Breast Cancer - The Art and Science of Early Detection with Mammography. Georg Thieme Verlag, Stuttgart, 2005.

10. L. Tab´ar & P. B. Dean. “Mammographic parenchymal patterns. risk indicator for breast cancer?” Journal of the American Medical Association 247(2), pp. 185–189, 1982.

11. E. M. Hadley, E. R. E. Denton & R. Zwiggelaar. “Mammographic risk assessment based on anatomical linear structures.”Lecture Notes in Computer Science 4046, pp. 626–633, 2006.

12. E. M. Hadley, E. R. E. Denton, J. Pont et al. “Risk classification of mammograms using anatomical linear structure and density information.” Lecture Notes in Computer Science 4478, pp. 186–193, 2007.

13. R. Zwiggelaar, S. M. Astley, C. R. M. Boggis et al. “Linear structures in mammographic images: Detection and classification.”IEEE Transactions on Medical Imaging 23(9), pp. 1077–1086, 2004.

14. R. N. Dixon & C. J. Taylor. “Automated asbestos fibre counting.” Institute of Physics Conference Series 44, pp. 178–185, 1979.

15. Anjan Adhikari, Dipesh Chakraborty, Rania Indu, Sangita Bhattacharya, Moumita Ray, Ramanuj Mukherjee, “ Drug Prescription Pattern Of Breast Cancer Patients In A Tertiary Care Hospital in West Bengal: A Cross-Sectional and Questionnaire-Based Study”, Asian Journal of pharmaceutical and clinical research, Vol 11, Issue 3, 2018.