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COMPARATIVE ANALYSIS OF DIFFERENT TECHNIQUES USED IN MAMMOGRAM TO ELIMINATE PECTORAL MUSCLES

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Abstract-

Breast cancer is a leading cause of death among all cancer diseases for middle-aged and older women. It is major health challenge all over the world and its occurrence has increased rapidly in recent years. Mammography is a valuable and cost effective tool used in breast cancer screening programs and is a well-known method for detection of breast tumors. Early detection and removal of the primary tumor is an essential and effective method to enhance survival rate and reduce mortality. The image segmentation is the basic step in the detection of tumors in various medical images. Breast region segmentation is an essential prerequisite in computerized analysis of mammograms. It aims at separating the breast tissue from the background of the mammogram. The detection and segmentation of the pectoral muscle in the Medio-Lateral Oblique (MLO) view of mammograms is essential for further analysis of breast anomalies. The presence of pectoral muscle may sometimes affect the detection of architectural distortion due to their similar characteristics with abnormal tissues. As a result pectoral muscle should be handled separately while detecting the breast cancer. There have been various techniques to remove the pectoral muscle and isolate the breast region. This paper gives a comparative analysis of the various existing techniques used for Elimination of Pectoral Muscle.

Keywords- Breast cancer, Pectoral Muscles removal, Mammograms, Medio-Lateral Oblique (MLO) view

I. INRODUCTION

A mammogram is an X-ray image of the breast and it is used to aid in the early detection and diagnosis of breast diseases in women. Currently it is recommended that women above 40 years have to regular undergo mammogram check every year for early detection of breast cancer. It can also be used to detect and diagnose breast disease in women experiencing symptoms such as a lump, pain or nipple discharge [2]. Mammography is currently the most effective imaging modality used by radiologists for the screening of breast cancer. Finding an accurate, robust and efficient breast profile segmentation technique still remains a challenging problem in digital mammography. Extraction of the breast profile region and the pectoral muscle is an essential pre-processing step in the process of computer-aided detection. Primarily it allows the search for abnormalities to be limited to the region of the breast tissue without undue influence from the background of the mammogram. The presence of pectoral muscle in mammograms biases detection procedures, which recommends removing the pectoral muscle during mammogram pre-processing [3]. However, mammograms are complex, textured images, and there is a substantial variation across the screening population, leading to difficulties in detection and diagnosis. In addition, the number of mammograms to be analyzed in the screening program is vast. It would be valuable to develop an algorithm using extracted features from the breast profile region, which is the Region of Interest (ROI). This would reduce the number of unnecessary biopsies in patients with benign disease and thus avoid patients' physical and mental suffer, with a bonus of reducing healthcare costs. Several research works have tried to develop Computer Aided Diagnosis (CAD) tools that could help the radiologists in the interpretation of the mammograms and could be useful for an accurate diagnosis. It is essential to extract the abnormal masses in mammogram so that we can perform computerized analysis of digital mammograms [4].

The current image evaluation criteria for the mammographic presentation of the pectoral muscle on the MLO view of the breast recommends that the inferior aspect of the pectoral muscle reaches the level of the nipple. However, many MLO mammograms fail this quality criterion of the image evaluation systems. In some mammograms the pectoral muscle is not present at all. This wide variability in the position of the muscle contour, together with the similarity between muscle and breast tissues make the detection a difficult task [5]. Pectoral muscle identification is often required for breast cancer risk analysis, such as estimating breast density. Traditional methods are overwhelmingly based on manual visual assessment or straight line fitting for the

pectoral muscle boundary, which are inefficient and inaccurate since pectoral muscle in mammograms can have curved boundaries [6]. The mammogram segmentation process is designed to find suspicious areas, and to separate the suspicious areas from the background that will be used for extracting features of suspicious regions. Many thresholding techniques have been developed for image segmentation [4].In most of the approaches of computer-aided detection of breast cancer, one of the preprocessing steps applied to the mammogram is the removal/suppression of pectoral muscle, as its presence within the mammogram may adversely affect the outcome of cancer detection processes [1].

The automatic detection and segmentation of the pectoral muscle in the medio-lateral oblique view of mammograms is essential for further analysis of breast anormalies. However, it is still a very difficult task since the sizes, shapes and intensity contrasts of pectoral muscles change greatly from image to image [5].

II. NEED TO ELIMINATE PECTORAL MUSCLE

A digital mammogram is shown in Fig. 1

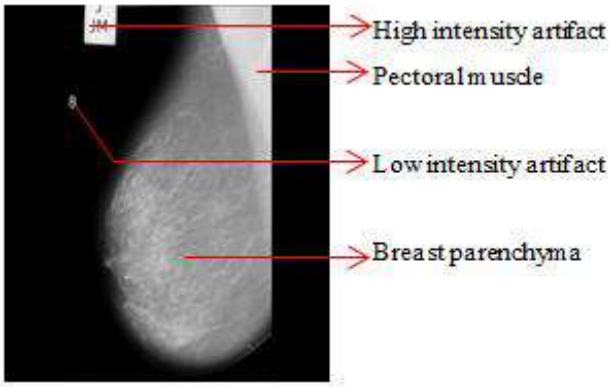


Fig.1. Digital Mammogram

The pectoral muscle is a thick, fan-shaped muscle, situated at the upper front (anterior) of the chest wall. It makes up the bulk of the chest muscles in the male and lies under the breast in the female. The pectoral muscle appears as a triangular opacity across the upper posterior margin [3] as shown in Fig.1. The pectoral muscle in medio-lateral oblique (MLO) mammogram images is one of the high intensity landmarks in the breast. As it can bias and affect the results of any mammogram processing method, it is often necessary to automatically identify and segment the pectoral muscle prior to breast tissue image analysis. The wide variability in the position of the muscle contour, together with the similarity between in muscle and breast tissues makes this a difficult task [2].

The pectoral muscle represents a predominant density region in most medio-lateral oblique (MLO) views of mammograms, and can affect the results of image processing methods. Intensity-based methods, for example, can present poor performance when applied to differentiate dense structures such as the fibro-glandular disc or small suspicious masses, since the pectoral muscle appears at approximately the same density as the dense tissues of interest in the image. The inclusion of the pectoral muscle in the image data being processed could also bias the detection procedures. Another important need to identify the pectoral muscle lies in the possibility that the local information of its edge, along with an internal analysis of its region, may be used to identify the presence of abnormal axillary lymph nodes, which may be the only manifestation of occult breast carcinoma [5].

In properly imaged MLO mammograms, the pectoral muscle is visible as a triangular region of high-density at the upper posterior part of the image. Its presence in mammograms poses an additional source of complexity in automated analysis as it may interfere with the results of image processing methods and induce a bias in breast cancer detection. The texture of the pectoral muscle may also be similar to some abnormalities and may cause false positives in the detection of suspicious masses [5]. Exclusion of the pectoral muscle facilitates automatic breast tissue identification and allows the radiologist to check for the development of cancers in the area overlying the pectoral muscle [4]

III. DIFFERENT TECHNIQUES USED IN MAMMOGRAM TO ELIMINATE PECTORAL MUSCLE

The following represent the different techniques used in Mammogram for eliminating the pectoral muscles

In paper [2], authors K.Vaidehi, T.S.Subashini proposed work in three steps. In the first step, the mammogram is oriented to the left to minimize computations. In the second step the top left quadrant of the mammogram which contains the pectoral muscle is extracted. Next, the pectoral muscle contour is computed using proposed algorithm. Totally 120 mammogram images were taken up for the study. The results obtained were compared with manually drawn contours by the radiologist and the accuracy obtained was 85%. Out of 120 images 11 images got over segmented and 7 images got under segmented and the true positive rate achieved was 90.2%.

In that paper [7], an approach to segmentation of the breast region with pectoral muscle removal in mammograms has been proposed based on a hybridization of ccl, fuzzy and straight line methods which are based on the pectoral muscles removal. The authors I. Laurence Aroquiaraj and K. Thangavel, utilizes a hybridization of CCL with Fuzzy, CCL with Straight line, and Straight line with Fuzzy. These methods were compared with each other by error measure, index measure and distance measure. Initial segmentation results on more than 322 mammograms have been qualitatively evaluated and have shown that method can robustly obtain an acceptable segmentation in 98.4% and 95.5% for breast-boundary and pectoral muscle separation in mammograms with different density types and preserve the tissue close to the breast skin line effectively.

In paper [8], the authors Sonali Bhadoria Asst. Prof, MAE, Pune ,Yash Bharwani ,Anikta Pati used methodology in which they extracted various features of the mammogram images and their ranges to remove the unwanted part of pectoral muscles which remains even after the segmentation. In that paper, to remove the Pectoral muscle first the mammogram image is transformed into number of equal tiles then Adaptive thresholding technique is used to segment the image by obtaining threshold, individually for each tile. Then various statistical features were extracted from each tile and their properties were analyzed. From that there were different ranges of the features for tumor region and pectoral muscles obtained and at last after studying the ranges of these distinct features, filters were designed to eliminate the pectoral muscles.

Nashid Alam and Mohammed J. Islam in paper [9] proposed an algorithm based on K-means clustering to eliminate the triangular area of pectoral muscle. The reduction of irrelevant noise and unwanted artifacts are also performed using morphological pre-processing and seeded region growing (SRG) techniques. The method suggested for detection was tested over 322 images of 161 women taken from mini-MIAS database, out of which the proposed algorithm is able to eliminate pectoral muscle, showing 94.4% true positive value, from 291 images successfully. Results of pectoral muscle elimination are divided into three groups: Good (90.37%), Acceptable (8.07%) and Unexpected (1.5%). That paper presents a new and efficient method for pectoral muscle detection in MLO view mammograms by combining k-means segmentation with some pre-processing parameters calculated from the regions obtained in the segmentation step. These measures are based on localization of pectoral muscle in mammograms and the increased gray-level value of pectoral muscle. A set of preprocessing steps including image morphology, contrast enhancement and noise filtering techniques have been applied to discard X-ray labels. The preprocessing segmentation processes reduce noise and edge-shadowing effect, accurately detect region of interest (ROI) for pectoral muscle.

Sreedevi S and Elizabeth Sherly in paper [10], combines Robust Outlyingness Ratio (ROR) mechanism with extended NL-Means (ROR-NLM) filter based on Discrete Cosine Transform (DCT) for the detection and removal of noise. That method removes Gaussian and impulse noise very effectively without any loss of desired data. For segmenting and removing pectoral muscles, this paper uses global thresholding to identify pectoral muscles, edge detection processes to identify the edge of the full breast and connected component labelling to identify and remove the connected pixels outside the breast region. The result shows that approach removes Gaussian and impulse noise effectively without any loss of desired data and overall gives 90.06% accuracy.

In paper [11], the authors Manasi Hazarika and Dr. Lipi B Mahanta proposed automated method for removal of pectoral muscle. The method has three main phases. In the first phase a triangular region is defined over the mammograms to isolate the pectoral muscle from the rest of the tissue. In the second phase a local region growing method is applied within the triangular area defined to suppress the pectoral muscle. In the last phase, the pectoral edge is refined using gradient information of the edge. The system is tested over 150 images taken from Mini MIAS dataset. Segmentation accuracy for the proposed method is obtained by comparing segmented areas with hand drawn segmentation masks. As per the conclusion a seeded region growing method is presented

to remove pectoral muscle from MLO mammogram images. The region growing is restricted within a well defined triangular area which divides the image into two areas, one with pectoral muscle and one without pectoral muscle. Thus it helps in restricting region growing within the area that contains the pectoral muscle only. This triangular area defined over an image covers the pectoral muscle for almost all types of images unless there is absence of pectoral muscle. The method shows considerably good result for pectoral muscle removal

Ref. No.	Title	Author Name and Year	Technique used	Qualitative Analysis of the paper	Database	Result
2	Automatic Identification and Elimination of Pectoral Muscle in Digital Mammograms	K.Vaidehi, T.S.Subashini, 2013	Connected component labelling is used to remove the high intensity artifacts. Then Artifacts removed image (1024x1024 size) partitioned into four quadrants of 512x512 each. The top left quadrant 512 x 512, which contains the pectoral muscle is the region of interest and at the pixels of the other three quadrants are changed to black.The region which contains the pectoral region is now thresholded with the value of 176 to obtain the binary image.	Accuracy obtained was 85%. Out of 120 images11 images got over segmented and 7 images got under segmented and the true positive rate achieved was 90.2%.	120 mammogram images from Mini-Mias database	Accuracy=85% True positi rate=90.2%
7	Pectoral Muscles Suppression in Digital Mammograms using Hybridization of Soft Computing Methods	I.Laurence Aroquiaraj and K. Thangavel	Hybridization of Connected component labelling, fuzzy and straight line methods	acceptable segmentation in 98.4% and 95.5% for breast-boundary and pectoral muscle separation in mammograms with different density types	322 mammographic images from MIAS database	The hybridizatio of fuzzy wi straight line metho is given more tha 96% of the cur segmentations
8	Removal of Pectoral Muscle in Mammograms using Statistical Parameters	Sonali Bhadoria, Yash Bharwani ,Anikta Pati, 2012	Mammogram images transformed into number of equal tiles. Then Adaptive thresholding technique is used to segment the image. Various statistical features were extracted from each tile and their properties were analyzed. After studying the ranges of distinct features filters were designed to eliminate the pectoral muscles	In this paper the plot of Standard deviation of image, mean of image and standard deviation of the histogram for pectoral muscle and tumor part is obtained and from different ranges shown were used to design the filters.	The input images have been taken from MIAS database.	Standard deviation of histogram is unique feature to find out the difference in pectoral muscle an tumor region
9	Pectoral Muscle Elimination on Mammogram Using K-Means Clustering Approach	Nashid Alam, Mohammed J. Islam 2014	Algorithm based on K-means clustering, morphological pre-processing and seeded region growing (SRG) techniques.	Proposed algorithm able to eliminate pectoral muscle showing 94.4% true positive value, from 291 images successfully. Results of pectoral muscle elimination are divided into three groups: Good (90.37%), Acceptable (8.07%) and Unexpected (1.5%).	322 images from mini-MIAS database	The success rate o proposed algorithm indicates 94.4% tr positive, 5% false positive and 1% false negative results.
10	A Novel Approach for Removal of pectoral muscles in Digital Mammogram	Sreedevi S, Elizabeth Sherly 2015	Combines Robust Outlyingness Ratio (ROR) mechanism with extended NL-Means (ROR-NLM) filter based on Discrete Cosine Transform (DCT), global thresholding, canny edge detection, Connected component labelling, gray level thresholding.	Overall gives 90.06% accuracy.	161 images from MIAS	Acceptable= 145(90.06 %) Unacceptable= 16(9.94 %)
11	A novel region growing based method to remove Pectoral Muscle	Manasi Hazarika, Dr. Lipi B Mahanta	The method has three main phases. In the first phase a triangular region is defined over the mammograms to isolate the pectoral muscle from the rest of the tissue. In the second phase a	Acceptable= 130 images=86.67% Partially acceptable= 8	150 images from Mini MIAS	Acceptable = 1 (86.67%) Partially acceptable=8

	from MLO mammogram images		local region growing method(. seeded region growing) is applied within the triangular area defined to suppress the pectoral muscle. In the last phase, the pectoral edge is refined using gradient information of the edge	images=5.33% Unacceptable= 12 images=8%	database	(5.33%) Unacceptable=12 (8%)
12	A Novel Approach for Classification of Mammograms using Longest Line Detection Algorithm and Decision Tree Classifier	A. M. Solanke, Manjunath and D. V. Jadhav 2019	Mammogram images are pre-processed using longest line detection algorithm to remove pectoral muscle. This algorithm is a combination of canny edge detector and hough transform. Then features such as GLCM, DWT and statistical features are extracted from pre-processed mammograms. Finally decision tree classifier is used to classify mammograms as normal and abnormal categories..	This method resulted into improved classification accuracy, specificity and sensitivity of 98.14%, 97.63% and 99.1% respectively	322 mammogr ams.	Accuracy= 98.14% Sensitivity = 99.1 specificity=97.63%
13	A novel multistage system for the detection and removal of pectoral muscles in mammograms	Idil IS_IKLI ESENER,, Semih ERG_IN, Tolga YUKSEL, 2018	A mammography image is first pre-processed By performing noise reduction background removal followed by artifact suppression processes. Then a pre-segmentation procedure is applied using region growing and line fitting is executed. Finally, pixels including pectoral muscle regions are removed from mammography images.	Some post-processing operations are employed for reducing the number of false positives, and consequently a segmentation accuracy of 94.40%, sensitivity of 89.62%, and specificity of 99.99% are obtained.	322 images from MIAS database	Accuracy= 94.40% Sensitivity= 89.62 specificity=99.99%
14	Removal of pectoral muscle based on topographic map and shape-shifting silhouette	Bushra Mughal, Nazeer Muhammad, Muhammad Sharif, Amjad Rehman, 2018	First, differentiation operator is used to detect the edge boundaries and to approximate the gradient value of intensity function. Then an accurate edge boundary of breast body is determined. Based on the end point of the breast body edges, a convex image is generated. Finally, a convex hull function is developed to produce a topographic map by means of convex image and breast body boundary which is applied on pre-processed mammograms to eradicate the unwanted pectoral muscle.	In this method, the Hausdorff distance (HD) is using the designated approach to attain the smallest mean rate as 3.52mm on the MIAS and 3.51mm on the CEDM.	322 mammogr ams and a 20 contrasts enhanced digital mammogr aphic images from MIAS	The rates of FP, FI Standard deviatio and the mean valu of the Hausdor distance are 0.9 5.67, 1.59 a 3.52% respectively

In paper [12], mammogram images are pre-processed using longest line detection algorithm to remove pectoral muscle. Then texture and statistical features are extracted from pre-processed mammograms. Finally decision ree classifier is used to classify mammograms as normal and abnormal categories. The authors A. M. Solanke, Manjunath and D. V. Jadhav present a novel CAD method to classify mammograms into normal and abnormal categories. In that method, mammograms are pre-processed by removing noise and unnecessary part. Noise is removed by applying series of morphological operations. Further, area above pectoral muscle is removed by using longest line detection algorithm. This algorithm is a combination of canny edge detector and Hough transform. The canny edge detector outperformed all other edge detectors. The features such as GLCM, DWT and statistical features are extracted from pre-processed mammograms. Finally decision tree classifier is used to classify mammograms as normal and abnormal categories. The proposed methodology is applied to 322 mammograms. This method resulted into improved classification accuracy, specificity and sensitivity of 98.14%, 97.63% and 99.1% respectively.

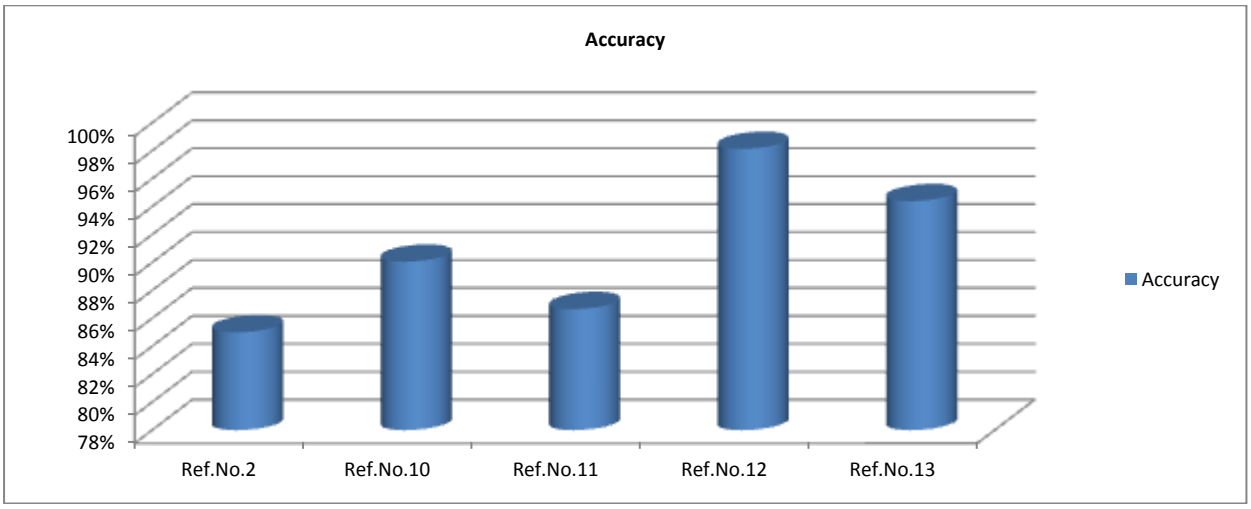
The authors Idil ISIKLI ESENER, Semih ERGIN, Tolga YUKSEL in paper [13], proposed a novel multistage scheme for pectoral muscle removal from mammography images and the performance of this system is verified using the publicly available MIAS digital mammogram database. This database is composed of mediolateral oblique mammography images including three different tissue types (fatty, fatty-glandular, and dense-glandular) with three health status types (normal, benign cancer,and malignant cancer).In the implementation of the proposed system, a mammography image is first pre-processed by performing noise reduction background removal followed by artifact suppression processes. Then a pre-segmentation procedure is applied using region growing and line fitting is executed. Finally, pixels including pectoral muscle regions are removed from mammography images with an accuracy of 94.40%, sensitivity of 89.62%, and specificity of 99.99% after some post-processing operations.

In paper [14], the authors proposed a novel approach to remove the pectoral muscle in terms of the mediolateral-oblique observation of a mammogram using a discrete differentiation operator. This is used to detect the edges boundaries and to approximate the gradient value of the intensity function. Further refinement is achieved using a convex hull technique. This method is implemented on dataset provided by MIAS and 20 contrast enhanced digital mammographic images. In that paper to assess the performance of the proposed method, visual inspections by radiologist as well as calculation based on well-known metrics are observed. For calculation of performance metrics, the given pixels in pectoral muscle region of the input scans are calculated as ground truth.

TABLE 1 STUDY ON THE DIFFERENT TECHNIQUES USED FOR ELIMINATION OF PECTORAL MUSCLES

I. COMARATIVE STUDY ON THE PERFORMANCE ANALYSIS ON THE RELATED WORKS DONE ON THE ELIMINATION OF PECTORAL MUSCLE

In this section, the performance analysis of different technique used for elimination of Pectoral muscle is compared with the various papers.



From the above graph, the method used in paper [12] gives the maximum accuracy than the other method used in various paper which compared with each other.

II. CONCLUSION

This paper presented a survey and the comparative analysis between various technique and method of image processing used in digital mammography to eliminate the pectoral muscle. The technique described in paper compare accuracy and segmentation detection algorithm for both single view and multi view mammograms and these techniques suitable for breast region segmentation and ROI segmentation.

REFERENCES

[1] K. Santle Camilus, V. K. Govindan, P.S. Sathidevi, " Pectoral muscle identification in mammograms," JOURNAL OF APPLIEDCLINICAL MEDICAL
PHYSICS, VOLUME 12, NUMBER3, summer 2011

[2] K.Vaidehi, T.S.Subashini, "Automatic Identification and Elimination of Pectoral Muscle in Digital Mammograms," *International Journal of Computer*
Applications (0975 – 8887) Volume 75– No.14, August 2013.

[3] Jawad Nagi, Sameem Abdul Kareem, Farrukh Nagi, Syed Khaleel Ahmed, " Automated Breast Profile Segmentation for ROI Detection Using Digital
Mammograms," 2010 IEEE EMBS Conference on Biomedical Engineering & Sciences (IECBES 2010), Kuala Lumpur, Malaysia, 30th November - 2nd
December 2010.

[4] H. Abdellatif1, T. E. Taha, O. F. Zahran, W. Al-Nauimy, F. E. Abd El-Samie, "K9 Automatic Segmentation of Digital Mammograms to Detect Masses,"
30th NATIONAL RADIO SCIENCE CONFERENCE (NRSC 2013) April 16-18, 2013.

[5] Jaime S. Cardoso, Igor Amaral, Inˆes Moreira, Pedro Passarinho, Joˇao Santa Comba, Ricardo Correia, Maria J. Cardoso, "Pectoral muscle detection in
mammograms based on polar coordinates and the shortest path," 32nd Annual International Conference of the IEEE EMBS Buenos Aires, Argentina,
August 31 - September 4, 2010.

[6] Chao Wang, "A novel and automatic pectoral muscle identification algorithm for mediolateral oblique (MLO) view mammograms using ImageJ,"
unpublished.

[7] I. Laurence Aroquiaraj, and K. Thangavel "Pectoral Muscles Suppression in Digital Mammograms using Hybridization of Soft Computing Methods,"
unpublished.

[8] Sonali Bhadoria, Yash Bharwani ,Anikta Pati, "Removal of Pectoral Muscle in Mammograms using Statistical Parameters,**"** International Journal of
Computer Applications (0975 – 8887) Volume 43– No.6, April 2012.

[9] Nashid Alam, Mohammed J. Islam, "Pectoral Muscle Elimination on Mammogram Using K-Means Clustering Approach," International Journal of
Computer Vision and Signal Processing, 4(1), 11-21(2014).

[10] Sreedevi S, Elizabeth Sherly "A Novel Approach for Removal of pectoral muscles in Digital Mammogram," International Conference on Information
and Communication Technologies (ICICT 2014),ScienceDirect/Procedia Computer Science 46 (2015) 1724 – 1731.

[11] Manasi Hazarika, Dr. Lipi B Mahanta, "A novel region growing based method to remove Pectoral Muscle from MLO mammogram images,"
unpublished.

[12] A. M. Solanke, Manjunath and D. V. Jadhav, "A Novel Approach for Classification of Mammograms using Longest Line Detection Algorithm and
Decision Tree Classifier,**"** International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-8
June, 2019.

[13] Idil ISIKLI ESENER, Semih ERGIN, Tolga YUKSEL, **"**A novel multistage system for the detection and removal of pectoral muscles in mammograms,"
Turkish Journal of Electrical Engineering & Computer Sciences (2018) 26: 35-49

[14] Bushra Mughal, Nazeer Muhammad, Muhammad Sharif, Amjad Rehman, Tanzila Saba, " Removal of pectoral muscle based on topographic map and
shape-shifting silhouette,"Mughal et al. BMC Cancer (2018) 18:778.