International Journal of Engineering, Science and Mathematics
Vol. 7Issue 3, March 2018,
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com Double-Blind Peer
Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

A REVIEW ON MEDICAL IMAGE PROCESSING: A CASE STUDY OF BREAST CANCER

Joshi Arpita[1] and Mehta Ashish[2]
[1,2]Department of Computer Science,
Kumaun University,
Nainital

Abstract: In modern era, there are high qualities of medical services and hospitals are equipped with modern technology, however the visible perception and detection of abnormality go through with imprecision in the detection of abnormality and cancer. This challenging task can be made easier and detection accuracy can be improved by various diagnosis systems. There are lots of digital image processing techniques that make the decision more accurate and more efficient. Breast cancer is one of the most common reason of death among females so early detection and diagnosis is very important for the survival of patient. In this paper we have studied various types of medical imaging techniques used for diagnosis of breast cancer such as X-ray Imaging, Ultrasound Imaging, Mammographic Imaging and Computer Aided Diagnosis system.

1. Introduction

In modern era, there are high qualities of clinical services and hospitals are equipped with modern technology, however the visible perception and detection of abnormality go through with imprecision within the detection of abnormality and cancer. Difficult challenge may be made easier and detection accuracy may be progressed through various diagnosis systems.

There are various kinds of medical imaging techniques used for distinct purposes and applications consisting of X- ray Imaging, Ultrasound Imaging and Mammographic Imaging etc. Medical Imaging processing comprises of various techniques and procedures which can be used to create images of human body for medical purposes and medical approach for the purpose of diagnosis of disease.

There have been various improvements over the technology and imaging techniques consisting of contemporary sensors and image acquisition systems with which the medical imaging systems are constructed. Mammography is one of the most common techniques to detect malignant and benign in its early stage or other abnormalities in breast images. X-ray imaging is one of the most challenging areas in medical imaging. Ultrasound images are beneficial for the prognosis to evaluate any damage inside the internal organs also there are a extensive variety of applications of ultrasound imaging due to its non-invasive and non ionizing nature.MRI also plays a vital role in the early detection of breast cancer.MRI techniques are

used for screening the breast and the brain. The technology is more costly than mammography and ultrasound imaging techniques. More than 42 years, digital image processing is taken into consideration to diagnosis the cancer automatically, however there are still demanding situations due to complexity of imaging data **[3, 8, 15].**

There are various problems in medical image processing that might cause problems in the process of prognosis and decision making. Poor image quality poses massive challenge that might have an effect on the decision making process. There are various factors causing poor quality of images consisting of imperfect tool, problem with data acquisition process and a few amount of noise. The usefulness of such images may be achieved the usage of contrast enhancement, sharpness enhancement, image magnification and reduction of distortion. The main challenges of medical image processing are:

(i) Poor image quality have an effect on the decision making process of medical imaging systems.
(ii) Processing speed
(iii) High noise levels
(iv) Low contrast
(v) Poor resolution

According to the **World Cancer Research Fund International report**, Breast cancer is one of the most common reasons of death among females. In the United Sates, cancer is the second most common reason of death and accounts for nearly 1 in every 4 deaths **[8, 11, 14].**

According to **nationalbreastcancer.org**, the female breast is collection of fats (adipose tissue).Breast has approximately 12-20 sections known as lobes (collection of smaller lobules that produce milk). Cancer begins in the cell which grows abnormally and make up tissue that is observed within the breast and different parts of the body. Breast cancer occurs when malignant tumor develop in breast.

In United State 1 in 8 women may be diagnosed with breast cancer and second leading cause of death among women, estimated 252,710 women will be diagnosed, more than 40500 will die, also 2470 men will be diagnosed and about 460 will die each year, 3.3 million survivors are alive**[1].**

According to **www.verywell.com**,tumor is the abnormal growth of cells however normal is known as benign(non-cancerous cells).Benign tissues are not harmful to the body, While abnormal growth of cells and develop uncontrollably in the body, they become malignant(cancerous cells). Malignant tissues are very aggressive and its removal is required, otherwise it can poke risk of life **[2].**

2. Techniques used in breast cancer detection

Medical image processing comprises of various techniques that are used for diagnosis and medical purposes. There may be an excellent impact on digital images for diagnosis purposes and digital image processing has emerged as an essential component of science and technology related to the biomedical image processing. Digital image processing with its diverse components and computer simulated algorithms are carried out the usage of computer systems to carry out evaluation of various digital images. There are various medical imaging techniques used for different applications such as Breast Cancer Imaging, Ultrasound Imaging, and Mammographic Imaging etc **[21].**

Mammographic Imaging

Mammogram consists of mammographic images used for the recognition of breast cancer as well as other similar disease. It is essentially a kind of X-ray output in which tissues are highlighted. For screening and diagnosis purposes distinctive types of mammogram are used. Some of them are mentioned as: (i) Screening Mammogram (ii) Diagnostic Mammogram (iii) X-ray Breast imaging using Mammogram.

X-ray is very vital within the early detection of breast cancer. Breast imaging using mammograms /X-rays is most important in the early detection of breast cancer **[8].**

Ultrasound Imaging

These types of images are based on the fact that sound is transferred to different form of energy as ultrasound patterns.3-D images can also produced using ultrasound imaging method. Ultrasound images are non invasive in nature and not helpful in the early detection of breast cancer. Ultrasound images are useful for the diagnosis of a person to assess any damage in the internal organs **[8].**

Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imaging technique is used for screening of breast cancer.MRI method has various features that assist in correct diagnosis of breast cancer.MRI has high sensitivity and low specificity.MRI can also depict many abnormalities which might be proved later not be cancerous. In the Breast Cancer diagnosis, MRI play an important role as it is non-ionizing, so it can be used in determining if the cancer has spread to the chest wall **[7, 10].**

Breast Thermograph Imaging

Thermal Imaging is an automatic imaging technique exploiting mapping of heat radiating from the breast with the assumption that cancerous tissue produces more heat than the ordinary breast tissue. Thermal imaging is a screening technique that is used for the diagnosis of the breast cancer. Breast Thermograph Imaging also called thermography. It is non-invasive method **[23].**

Tomography Imaging

Tomography imaging approach is used to create 3D images of the interior of the body. There are various types of Tomography imaging techniques including Computed Tomography (CT), Positron Emission Tomography (PET).These techniques also are beneficial for the purpose of correct analysis of breast cancer into benign and malignant**[8,9].**

3. Steps involved in Computer Aided Diagnosis System for breast cancer detection

There are various models available for the prognosis and early detection of breast cancer. For the purpose of early detection and analysis of breast cancer, Computer Aided Diagnosis (CAD) System may be very useful. There are various soft computing tools including Neural Network, Genetic Algorithms as well as various machine learning techniques available for enhanced classification and optimization of outcomes which can also help the doctors/researchers working towards detection for the purpose of diagnosis of the breast cancer or different types of cancers.

Mammography is very vital approach to detect breast cancer.The primary goal of CAD system is to discover abnormalities and suspicious regions in mammograms and different imaging techniques.

There are various steps involved in Computer Aided Diagnosis system. These steps are as follows:

(i) Preprocessing

Preprocessing is the first step in Computer Aided Diagnosis System. Many techniques require that the chosen features are on the identical scale for optimal overall performance that's carried out through transforming the features within the range [0, 1].In this step, Firstly, we shall load the breast cancer dataset from different available sources.The dataset contains different instances.The data will be pre processed to improve the quality of data.The dataset contains many missing values.Missing value is the common property of large datasets. Many

Image processing techniques do not like missing values.So we can remove rows with missing values **[8, 13].**

(ii) Image Enhancement

These techniques are used to enhance the quality of the image. Quality can be improved through increasing the contrast and brightness of original image. There are basically two kinds of image enhancement techniques: spatial domain techniques and frequency domain techniques. Spatial domain techniques directly operate on the pixels. Spatial domain techniques includes Binary image output, negative of an image, log transformation, power law transformation, contrast enhancement, contrast stretch, spatial filtering and so on. Removing noise through the usage of appropriate method is a difficult assignment for the researchers. There are various spatial domain filters, which can be used for the purpose of reducing various kinds of noises. Low pass filter, high pass filter, high boost filter, Frost filter and Variance filter and so on comes under this class **[5, 12].**

In frequency domain techniques, Fourier transform is computed of both original image and appropriate filter function. The generally used smoothing domain filters are **[5, 18]:**
1. Ideal low pass filter
2. Butterworth low pass filter
3. Gaussian low pass filter

Image Enhancement plays an essential role in the analysis of mammography imaging, ultrasound imaging and other techniques.

(iii) Feature Extraction and Statistical Parameters

With the help of feature extraction technique, we are able to extract appropriate and vital features of any digital image processing strategies. These features are used to assess the system performance for the detection of tissue like breast tissue. This method is very essential aspect that directly influences the classification outcomes. There are various statistical parameters as well as image features used in the assessment of the performance of outcomes of the Computer Aided Diagnosis System. Some of the essential features are:

(i) Signal to Noise Ratio
(ii) Peak Signal to Noise Ratio

(iii) Mean Square Error
(iv) Root Mean Square Error
(v) Mean Absolute Error
(vi) Entropy

There are also shape related features occurs which helps in describing an image. Some of the Shape related parameters are **[6, 8, 25]:**

1. Distance
2. Perimeter
3. Convex Perimeter
4. Major and Minor axe
5. Centre of Gravity
6. Axes of Interia
7. Aspect Ratio
8. Eccentricity
9. Circularity Ratio
10. Rectangularity
11. Convexity
12. Solidity

Cooccurrence matrix is used for the measurement of texture of an image. **Principal Feature Analysis (PFA**) is similar to principal component analysis which is basically used in the statistical pattern recognition applications.An important method called **snakes boundary detection** method also introduced in 1988 by Kass.Using this method, a shape is fixed and made flexible in terms of the parameters defining the shape. We can also use **Discrete Fourier Transform** and **Discrete Wavelet Transform method** for feature extraction **[4, 8, 20, 22].**

The efficiency of Computer Aided Diagnosis system may be determined on the basis of some of the statistical parameters which might be computed using appropriate methods. Some of the parameters used for the evaluation of Computer Aided Diagnosis techniques are:

True Positive (TP)

In this situation the prediction is true. In other words, in the true positive case the suspected abnormality is malignant.

True Negative (TN)

A case, in which there is no detection of abnormality in healthy man or woman. In other words, in true negative case no signs and symptoms are found truly.

False Positive (FP)

A case, in which detection of abnormality is determined in healthy person. i.e., the prediction of the presence of abnormality is false.

False Negative (FN)

A case, in which no detection of malignant is found, proves to be not true.

Another terms known as Accuracy, Sensitivity, Specificity, Precision are used for evaluating the overall performance of the model.

(i) Accuracy can be calculated as:

Accuracy=$(\boldsymbol{TP}+\boldsymbol{TN})/(\boldsymbol{TN}+\boldsymbol{TP}+\boldsymbol{FP}+\boldsymbol{FN})$

(ii) Sensitivity can be calculated as

Sensitivity=$\boldsymbol{TP}/(\boldsymbol{TP}+\boldsymbol{FN})$

(iii) Specificity can be calculated as:

Specificity = $\boldsymbol{TN}/(\boldsymbol{TN}+\boldsymbol{FP})$

(iv) Precision can be calculated as:

Precision = $\boldsymbol{TP}/(\boldsymbol{TP}+\boldsymbol{FP})$

The confusion matrix for the data set is then computed using these values into above equations to find Accuracy, Sensitivity, Specificity and Precision **[8, 13, 19].**

(iv) Image Segmentation

Image Segmentation is one of the most essential tasks in the medical image processing. Image segmentation is very much needed in medical image processing .Image Segmentation is generally used to find ROI (Region of Interest) are basically referred to as segmentation techniques that assist in segmenting the foreground from the background. In the analysis of image, it is very important that we can differentiate between ROI and rest part (background).

The primary goal of image segmentation is to get the region of interest extracted and detected and essential features of pictures are highlighted. There are several research papers available discussing various problems related to the image segmentation. The image segmentation system cannot be applied efficiently if the gray levels of various objects are quite similar. Some other problems are:

(i) Choice of good segmentation technique
(ii) Measuring the performance of techniques
(iii) Impact of various techniques on the image analysis

Some of the techniques which are used for the image segmentation process are listed as**[8, 16, 24]**:

(i) Watershed method is one of the most important methods for image segmentation.
(ii) K-Means clustering method

(iii) Self Similar Fractal method

K -Means clustering and Self Similar Fractal have better results in terms of entropy values but watershed has the highest Signal to Noise Ratio. Due to the non linear nature the Self Similar Fractal, it has excellent visual quality and detail preserving properties. Neural Network is one of the soft computing techniques used for image segmentation, divided into two categories **[8, 17, 19]:**

(i) Supervised Methods
(ii) Unsupervised Methods

(v) Classification

Classification is the last step in Computer Aided Diagnosis system which play a vital role in the implementation of the computer aided diagnosis of mammography and other imaging techniques because it helps in distinguishing the regions exactly. Once images are enhanced, segmented and the features are extracted, classification process is applied. A number of techniques used in the classification process are available in various literatures.

Soft Computing techniques as well as various machine learning techniques are very useful in the medical imaging for several purposes such as classification, training of samples, optimization etc.

4. Conclusion

An extensive literature survey over the applications of digital image processing indicates that it is broadly used in medical image processing and its related applications such as cancer detection, especially for the purpose of early detection and diagnosis of breast cancer into benign and malignant.Different tools including Mammography Imaging, Ultrasound Imaging and so on are used for the detection of breast cancer.There are various challenges for detection of breast cancer.The quality of image required is very high and minor variation would possibly bring about incorrect diagnosis of breast cancer. The Computer Aided Diagnosis system involves various steps to evaluate the machine performance consisting of Preprocessing, Image Enhancement, Image Segmentation, Feature Extraction, Classification and Performance Measurement using different statistical parameters that facilitates the researchers to correct diagnosis of breast cancer into benign and malignant.

References:

1. Available: www.nationalbreastcancer.org.
2. Available: www.verywell.com.
3. B.Stenkvist,S.Westmannaeser,J.Holmquist,B.Nordin,E.Bengtsson,J.Vegelius,O.Eriksson,C.H. Fox," Computerized Nuclear Morphometry as an Objective Method for Characterizing Human Cancer Cell-populations", Cancer Research, Volume 38,pp.4688-4697,(1978).
4. Berbar A., Mohamed,"Hybrid methods for feature extraction for breast masses classification", Egyptian Informatics Journal, Volume 19, Issue 1, pp.63-73, (2018).
5. C. Rafael Gonzalez, E. Richard Woods, "Digital Image Processing", 2nd ed., Prentice Hall of India, New Jersey, (2002).
6. Choras, Ryszard, S.,"Image Feature Extraction Techniques and Their Applications for CBIR and Biometrics Systems", International Journal of biology and biomedical engineering, 1(1), pp.231-238, (2007).
7. Constance D Lehman, Mitchell D Schnall,"Imaging in Breast Cancer: Magnetic resonance imaging",https://www.ncbi.nlm.nih.gov.
8. Sinha R.G., Patel Charan Bhagwati,"Medical Image Processing: Concepts and Applications", PHI, (2014).
9. Geoff Dougherty, "Digital Image Processing for Medical Applications", "Cambridge University Press", (2015).
10. Gheonea Ioana Andreea,Raluca Pegza,Luana Lascu,Simona Bondari,Zoia Stoica,A.Bondari,"The Role of Imaging Techniques in Diagnosis of Breast Cancer", Current health sciences journal,Vol-43,Issue-4,(2017).
11. I.WCRF, Breast cancer statistics, Available: http://www.wcrf.org/int/cancer-facts-figures/data-specific-cancers/breast-cancer-statistics.
12. Jain, A.K.,"Fundamentals of Digital Image Processing", Pearson Education, Fourth Indian Reprint, (2005).
13. Joshi Arpita,Mehta Ashish,"Comparative Analysis of Various Machine Learning Techniques For Diagnosis Of Breast Cancer",International Journal on Emerging Technologies,8(1),pp.522-526,(2017).
14. M. Garcia, A. Jemal, E. Ward, M. Center, Y. Hao, R. Siegel, M. Thun, Global, "Cancer Facts and Figures", (American Cancer Society Atlanta, GA), (2007).
15. N.Hatipoglu, G.Bilgn,"Classification of Histopathological Images Using Convolutional Neural Network,"2014, 4th International Conference on Image Processing Theory, Tools and Applications (ipta), pp.295-300, (2014).

16. N.Salman, C.Q.Liu,"Image Segmentation and Edge Detection Based on Watershed Techniques", International Journal of Computers and Applications, 25(4), pp.258-263, (2003).
17. Pal, N.R., Pal, S.K.,"A review on image segmentation techniques", Pattern Recognition, 26, pp.1277-1294, (2003).
18. R.Gonzalez, R.Woods (2008),"Digital Image Processing", 3rd ed., Prentice Hall of India, (2001).
19. Sharma, Dinesh K., Gaur, Loveleen and Okunbor, Daniel, "Image Compression and Feature Extraction with Neural Network", Proceedings of the Academy of Information and Management Sciences, 11(1), pp.33-38, (2007).
20. Soni Diksha, Gupta Kumar Yogesh, Dubey Savita,"Empirical Study of DWT and FFT Techniques to Extract Intensity Based Features From the Images", International Research Journal of Engineering and Technology, Volume-03, Issue-10, (2016).
21. Susan G.komen,"Imaging Methods Used to Find Breast Cancer", https://ww5.komen.org.
22. Sushma S.,Balasubramanian S.,Latha K.C.,"DWT based Feature Extraction for classification of Untreated MRI Mammogram of Breast Cells and Normal Cells", International Journal of Computer Applications(0975-8887),Volume 157-No 8, (2017).
23. Thermography,http://www.breastcancer.org/symptoms/testing/types/thermography.
24. V. Grau, A.U.J. Mewes, M. Alcaniz, R.Kikinis, S.K.Warfield,"Improved watershed transform for medical image segmentation using prior information", IEEE Transactions on Medical Imaging, 23(4), pp.447-458, (2004).
25. Zhang, D., Lu, G.,"Review of shape representation and description techniques", Pattern Recognition, Vol.37, pp.1-19, (2004).