The Breast Cancer Detection Approaches: A Review

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Abstract

This paper presents various medical image modalities employed for the prediction or detection of Breast carcinoma which is indeed a majorly occurring types of cancer in woman's and also encapsulates the various techniques and approaches devised for the early screening and detection of breast cancer which either based on the conventional image processing and other advanced techniques. This paper tried to presents the various approaches in a simplified manner so that references can be taken to come up with the more advanced and robust methods for the detection and prediction of breast carcinoma (Cancer). All most, all of these approaches are based on the highly advanced technologies such as medical image processing and then techniques based on machine learning or deep learning. This paper is an attempt to illustrate and review some of the previously proposed approaches employed for the early detection of cancer of breast. These below mentioned prediction and detection techniques based on image processing and machine learning or deep learning provides an overview about the affordability, reliability and outcomes of each techniques.

Keywords

Mammograms, Mammography, Ultrasound, Image Segmentation, Machine Learning etc.

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Introduction

Breast cancer is also known as the Breast carcinoma which is one of prehistoric type of cancer found in humans. Because of this fact, this cancer has been studied breifly and researched in order to deal with it in a scientific manner and came out with better medical means to cure the cancer. As a result of such studies and research on cancer, there are nowadays various recently invented techniques and methodologies used for the timely prediction of breast cancer. The second important cause of death is eventually the Breast cancer after lung cancer. In women; the breast cancer usually occurs and occurs in men very rarely. The statistics shows that six percent of women in India die due to breast cancer. The disease can be cured if it is detected early. The modern medical imaging has revolutionized this field of detecting cancer with the aid of computing devices. This survey papers consist of three sections. The first section deals with crisp knowledge about the breast cancer and its types. The second deals primarily with the various medical image modalities used for the diagnosis of breast cancer in a tabular manner simply high lightening their advantages and limitations. The last section is very important and brief as it simply encapsulates the various semi-automated and automated approaches devised and employed for the timely detection and screening of cancer of breast in a tabular manner.

Types of Breast Cancer

The hysterical augmentation of breast cells is Breast cancer. The tumour is cancerous if the cells can invade tissues in the surrounding or even spread to remote regions of the human body. Breast cancer begins from different parts of the body. They are classified depending upon where they originate.

a. **Ductal cancer:** A cancer that begins in the duct which carries milk to the nipple.
b. **Lobular cancer:** A lobular cancer is a cnacer that primarily occurs in the milk producing glands of the breast organ.
c. **Inflammatory breast cancer:** This type of breast cancer is not that common. It makes the skin appear thick and pitted. It makes the skin red and feels warm.
d. **Paget disease of the nipple:** The cancer begins in the ducts of breast and spreads to the skin of the nipple and then to the dark circle around the nipple.
e. **Phyllodes tumour:** This cancer develops in the stroma of the breast.
f. **Angiosarcoma:** This variety of cancer begins in cells that line lymph vessels or blood vessels.

Modalities Used for Detection

Medical imaging is the procedure or system used to represent the interior functioning and structure of human body. Medical imaging seeks to disclose interior structures veiled by the skin and bones, as well as to detect and treat disease. There are various medical imaging modalities used for detecting breast cancer at early stages.

A. Mammography In it, the X-ray is used as a diagnostic tool. Low-dose X-rays are used to see inside the breast. It works as exposing a body organ to minute dose of radiation.

a. Digital Mammography

The FFDM (Full-field digital mammography) is also known as the DIGITAL MAMMOGRAPHY. In it instead of the x-ray film, electronics is used that transforms these x-rays into images of the breast

known as Mammographic images. Then the radiologist used these images for the screening purpose and performs diagnosis.

b. Computer Aided Detection

Computer aided detection approaches simply works by searching in the mammographic images digitized for not normal areas of mass and density that may predict the presence of cancer.

c. Breast Tomosynthesis

The 3D mammogram is also known as the breast tomosynthesis. It is a type of imaging of advanced formin which various images are taken from different differen angles and then merge to form an image database.

B. Thermography This method is a non-ionizing method of studying internal structure. The cancer is identified by the thermal indicators in the infrared images. Infrared radiations are emitted from the objects which are above the absolute zero temperature. The radiation is directly proportional to the temperature. It increases as the temperature increases. The infrared images are captured by using the infrared cameras[1]. The high temperature at the skin indicates the presence and level of cancer. This method is sensitive to physiological changes that are the symptoms of cancer or precancerous stage which may lead to the formation of tumour. This method is very simple method to detect cancer. The results can be obtained quickly with less observer bias. But on the other hand the obtained result may not be accurate, as they depend upon the temperature of the body.

C. Sonography Sonography is a medical imaging tool used for diagnosing or detecting breast cancer. This technique is based on the application of ultrasound. Ultrasound is a sound whose frequency is greater than the human audible frequency (>20,000Hz). The ultrasound images are made by sending pulses of ultrasound into tissues of the body. Then the sound echoes off the tissue and they are recorded and converted into an image. Different tissues reflect varying degree of sound[1]. The transducer is a hand-held device that is used to scan the breast and indicate the flow of blood and movement of tissues. The ultrasound is used for looking at some changes in the breast which are not seen in the mammogram. The most robust means to trace out if the abnormality is either containing solid or any liquid is the Sonography. The Sonography can detect tumour quickly and easily.

D. Doppler Ultrasound This method is used to monitor the blood flow in the breast. It shows the blood flow through the blood vessels. The Doppler ultrasound waves are passed through the breast and they echo from the tissues. These echoed waves are then converted into an image and displayed in the screen. During Doppler ultrasound, a transducer which is a a hand-held device is taken lightly above the blood vessels over the skin. It transmitts and also receives amplified waves of sound. The intense waves of sound return off from the solid subjects, involving the blood cells. The motion of blood vessels makes changes in the pitches of the sound waves. If there is no flow of blood, there will not be any change in pitch. By using the reflected sound waves, a graph or a picture is generated and analysed for detection of tumour.

E. Colour Doppler Colour Doppler is a tool which is easy to use and it is available in most ultrasonic imaging devices. It provides information about the vascularisation in tissues. In order to demonstrate very slow flow, it is necessary to apply minimal pressure on the breast, thus avoiding compression of blood vessels. It detects the blocks in the flow of blood and blood flow through the lumps and thus the tumour can be detected early.

F. Magnetic Resonance Imaging The MRI imaging technique mainly based on the use of radio frequency pulses and magnetic field. In it, the human body organ is exposed to very strong magnetic rays. In order to know functioning and health of the bones, internal organs, tissues etc. MRI is used. Once the medical images are taken then they are displayed on to the computer screen and transmitted into electronic signal and the details are printed. Hence for the purpose of diagnosis, the image of both the breast simultaneously can be captured using the MRI. Even the MRI can be used to easily detect any lymph nodes, abnormalities and tumour in armpits. Even in younger women, the MRI is being used to detects dense breast tissues.

G. Positron Emission Tomography Specially for detecting the cells and area that are affected, the PET is used. In this radiopharmaceutical called Fludeoxyglucose is injected first. This Fludeoxyglucose emits gamma rays which are recorded by the scanner and as a result of it, the PET images are created and analysed. Especially where the signals are strongly accumulated, it's the suspicious area.

Table 1. Medical image modalities with their advantages and disadvantages

S.No	Medical Image Modality	Advantages	Disadvantages
1	**Mammography**	• Mammogram screening reduces breast cancer mortality. • Detects very small breast cancers before they become palpable. • Improves survival rate through early detection.	• Not 100% accurate; false negatives may occur. • Uses X-rays, exposing the patient to a small amount of radiation. • May cause discomfort during the examination.
2	**Thermography**	• Covers a large area for cancer assessment. • Detects abnormal regions through infrared colour variations. • Fast diagnosis. • Safe technique without ionizing radiation.	• Cannot accurately localize disease. • High temperature may be caused by conditions other than cancer. • Ineffective for slow-growing tumours. • Cannot determine tumour size.
3	**Sonography**	• Quick and non-invasive. • Painless and inexpensive. • Useful for evaluating breast masses.	• Lower diagnostic accuracy than some imaging modalities. • Cannot accurately determine tumour grade.
4	**Doppler Ultrasound**	• Non-invasive examination. • Quick, economical and easy to perform. • No radiation exposure. • Suitable for soft tissue imaging.	• Limited image resolution. • Strong reflection occurs at tissue–gas interfaces.
5	**Colour Doppler**	• Detects blood flow direction and velocity. • Rapidly identifies abnormal blood flow.	• Image quality depends on instrument performance.
6	**Magnetic Resonance Imaging (MRI)**	• Excellent for soft tissue visualization. • No ionizing radiation. • Detects blood flow abnormalities.	• Claustrophobic patients may experience discomfort. • Produces loud acoustic noise. • Requires high electrical power and is expensive.
7	**Positron Emission Tomography (PET)**	• Small patient movements usually do not affect the scan.	• Lower spatial resolution than MRI. • Repeated radioisotope exposure is limited. • Expensive imaging modality.

Literature Review

This section is further sub divided into three subsections illustrating the developments in the domain of detection of breast cancer using conventional image processing or segmentation, breast cancer detection based on machine learning and finally breast cancer detection using deep learning techniques.

The following methods like region growing, Thresholding and edge-based method etc. are all examples of the conventional image processing approaches employed for the prediction of cancer of breast. The discontinuity and similarity in the image are the two classified image segmentation procedures. The

thresholding and edge based segmentation are two classification of discontinuity method mentioned above and the region based segmentation belongs to the similarity method.

Image Processing and Segmentation

Table 2. Approaches based on image processing and segmentation

S.No	Author	Techniques Used
1	M. Vasantha, V.S. Bharti et al. [2]	Denoising is performed using a low-pass filter to remove noise and enhance image quality before further processing.
2	J. Nagi [3]	An adaptive mean filtering technique is proposed to smooth neighbourhood pixels while preserving image information.
3	J. Shan, W. Ju et al. [4]	Introduces an improved mean filtering approach that replaces inaccurate pixels with neighbouring pixel intensities to suppress Gaussian noise and improve image quality.
4	K. Thangavel et al. [5]	Gray-scale mammogram preprocessing is carried out to improve image quality and contrast before further analysis.
5	I.K. Mitra, S. Nag et al. [6]	A seeded region growing algorithm is employed to segment tumour regions based on connected region expansion.
6	I.K. Mitra, S. Nag et al. [7]	Fusion-based segmentation combines seeded region growing with adaptive segmentation to distinguish normal and abnormal tissues.
7	D. Dinsha [8]	CLAHE preprocessing followed by fuzzy C-means and K-means segmentation. Features are extracted and classified using SVM and Bayesian classifiers.
8	S. Shanti et al. [9]	Artificial Bee Colony optimization removes noise, fuzzy C-means performs ROI extraction, and eighty-four features are extracted.
9	K.G. Rajiv, K. Marcus et al. [10]	Optimized classification using fuzzy rule-based genetic algorithms during preprocessing achieved improved classification performance.

Machine Learning

Deep Learning

Conclusion

After going all these different approaches employed for breast cancer detection and prediction based on Conventional image processing and Image segmentation, Machine learning and deep learning, it is quite evident that all these approaches are having their own set advantages and flaws. In present times especially the approaches based on machine learning and Deep learning are looking more promising in terms of providing accurate and sensitive results which are attracting the researchers to pursue more and more research in these fields. The ultimate advantage of approaches based on the above mentioned domain lie in their capability to automate the task of prediction and detection with high accuracy and eventually help the physicians to diagnose the breast cancer in a much better way.

Table 3. Approaches based on machine learning

S. No.	Author's Name	Methods	Dataset	Accuracy	Rem
1	Pendharkar [11]	The proposed approach is a combination of mathematical, association, statistical and neural techniques to identify breast cancer patterns.	Dataset consists of 479 patients.	66–72%	DEA patte
2	Delen D., Walker G. *et al.* [12]	Decision Trees, Artificial Neural Networks and Logistic Regression are used for survivability prediction.	Dataset contains approximately 200,000 patients. Ten-fold cross-validation is used for evaluation.	89–93%	Futu corre accu
3	Chaurasia V., Pal S. [13]	RepTree, RBF Network and Simple Logistic classifiers are compared.	University Medical Centre dataset with 286 cases and 10 attributes.	71.32–74.47%	Simp attri mali
4	Hiba A., Hajar M., Hassan A.M. *et al.* [14]	Decision Tree (C4.5), Naive Bayes, Support Vector Machine and k-Nearest Neighbour algorithms are compared.	Wisconsin Breast Cancer dataset from the UCI Repository containing 699 instances.	97.13%	SVM rate
5	Wang K.J., Makond B. *et al.* [15,16]	Hybrid classifier combining PSO and SMOTE with 1-NN, Logistic Regression and C5 Decision Tree.	SEER dataset (1973–2007) containing 973,125 cases. After preprocessing, 215,221 instances with 20 variables were retained.	91.495%	The canc canc

Table 4. Comparison of deep learning methods for breast image analysis

S. No.	Author	Methods	Architecture of Deep Learning	Breast Image Analysis	Remarks
1	A. Albayrak, G. Bilgin et al. [17]	Mitosis detection	CNN	Histopathology	End-to-end
2	F.A. Spanhol et al. [18]	Breast cancer classification	CNN	Histopathology	End-to-end
3	H. Chen et al. [19]	Mitosis detection	FCN & CNN	Histopathology	Transfer learning
4	S. Albarqouni et al. [20]	Mitosis detection	CNN	Histopathology	End-to-end
5	J. Xu et al. [21]	Nuclei classification	SSAE	Histopathology	End-to-end

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