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A Progressive Review on Early Stage Breast Cancer Detection

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Abstract - *Breast cancer is one of the persistently diagnosed disease in women, which leads to the primary cause of cancer-related death in women. The early detection of cancerous tissue will aid in recovery and treatment of it and can save more lives. The detection of breast cancer is challenging using mammography, as dense tissues can overlap in screening. Now and again, ultrasound and MRI have likewise been utilized for breast cancer growth screening. Numerous methods have been utilized for the location of inconsistencies in the breast. For breast malignant growth discovery at the underlying stage, many examination works have been finished. Machine learning is frequently used for detection. Currently, the new technique, deep learning, is used to classify cancer. Deep learning is a high-level sort of machine learning. For the classification of images, deep learning algorithms like Convolutional neural networks can be used. In this study, we have presented a progressive review of deep learning algorithms for early-stage breast cancer detection using imaging modalities.*

Key Words: **Breast cancer, image processing, early stage detection, machine learning, deep learning**

1. INTRODUCTION

Breast malignant growth is the normal obtrusive disease in women and is the main source of disease passing in ladies in the current year. Out of a wide range of malignant growths, breast cancer disease has turned into a significant health concern. Cancer develops when the uncontrolled growth of abnormal cells in the breast starts and interacts with normal cells and makes them malignant. Breast cancer cells form a tumour or lump. But most breast lumps are benign and not malignant (cancer). Benign tumours are type of tumour that does not spread to other cells of the body. Breast cancer begins in the ducts or glands as per the type of cancer cells. According to the World Health Organization (WHO), in 2020, there were more than 5 million cases and 2.3 million women diagnosed with breast cancer and 685,000 deaths globally [12]. As per the recent report of the National Cancer Registry Programme (NCRP), the number of cancer cases in India is expected to increase from 13.9 lakh in 2020 to 15.7 lakh by 2025 which shows a nearly 20% increase in cases [13]. Many diagnostics techniques like ultrasound, mammogram, MRI, histopathology and Biopsy can be used for detection and classification for breast cancer.

To determine the issue in regards to breast cancer disease, there are many deep learning and machine learning procedures present. The grouping of tumour growths should be possible by both the techniques. In this paper, we have reviewed the work about different techniques used for the classification and detection of breast cancer.

2. LITERATURE REVIEW

A brief review of segmentation, feature selection and classifier for early stage breast cancer detection is reviewed in this progressive review section. Here the authors have discussed about various segmentation process, features and classifiers with their merits and demerits for early stage breast cancer detection. Machine learning and deep learning approaches have been discussed for early-stage breast cancer detection and their role for detection and diagnosis of breast cancer and assistance in the treatment, recovery and decrease the chances of critical situations has been discussed.

In this research work, Apparna Allada et al. [1] have stated, early cancer consciousness can reduce the casualty rate. They have proposed an AI machine learning model, wherein the model gets trained by parameters like radius, area; smoothness, compactness, and perimeter are taken. A total number of five breast cancer cases have been detected from mammograms. It has also been classified if they are benign or malignant tumours. By using this method the location of the tumour was also detected in the images. The model is prepared with the help of an auto AI service in the IBM cloud and that can be sent in web or mobile applications.

Priyanka et al. [2] has given a comparison between machine learning and deep learning techniques. Machine learning techniques have more satisfactory results but for images dataset, it is not preferable. The SVM classifier which is machine learning based algorithm works better on binary data compared to multiple data. From the research work, it has been proved that the ANN technique gives better results compared to the CNN technique. The comparison between two CNN models has also been mentioned. CNN technique is used to work on images dataset as machine learning only gives better results for linear data. To get better results compared to machine learning, a deep learning technique is used.

Pavithra S. et al. [3] have proposed, a CAD framework is created fusing pre-processing by Speckle Reducing Anisotropic Diffusion (SRAD) for better enhancement of ultrasound images and speckle noise reduction, and to locate the suspicious areas segmentation process has been performed. In this research process, they have work on 160 ultrasound images as it was suggested ultrasound can detect anomalies in dense breast more precisely. For the segmentation process, active contour method is used. The feature extraction using Gray Level Co-occurrence Matrix (GLCM) and three different classifiers are used for classification of breast ultrasound images. The Random Forest classifier provides better accuracy than Decision tree classifier and KNN.

In this article Wei-Hsin Yuan et al. [4] have reviewed the work of using Ultrasonography along with Mammography. It has been stated that ultrasonography + mammography gives 96% sensitivity compared to mammography alone (only 74%). For the detection of breast cancer with great accuracy, the combination of ultrasound and mammography screening provides better sensitivity. However, the diagnostic specificity of ultrasound is low for breast cancer compared to mammography. The use of ultrasound for screening decreases the number of false-negative biopsies and as well as it will be cost-effective.

Jose Daniel Lopez-Cabrera et al. [5] has used ROI image segment instead of full image. They have given two different classification architectures which was implemented as they provide better accuracy compared to other works. The pre-trained network Inception v3 was used. The accuracy of getting the results from these two CNN architectures was 86.05%. They have also used both the neural networks in series from which, it has provided the accuracy of 88.2%.The performance was also great for the routine clinical test as the image processing time was less than 1 second. Due to only ROI segment of the image, precision and efficiency of result is more.

Anji Reddy Vaka et al.[6] has proposed an innovative method to detect breast cancer. The Deep Neural Network with Support Value (DNNS) method is used and applied on 8009 histopathology images having various magnification levels. The method has provided better quality images and improved efficiency. The quality of image has been helpful for better prediction. The images have to pass through pre-processing stage in order to remove noise. The feature extraction and segmentation of the images gives accurate results. They have also compared the proposed novel method with existing method and showed how DNNS method is better compare to others. The DNNS method has given 97.21% accuracy and 97.9 % precision, which are the highest values among the other methods mentioned in the paperwork.

Kushangi Atrey et al., for breast cancer detection both mammogram and ultrasound images are used [7]. The abnormal region of interest is captured from the images manually. The FCM, K-means, and DPSO methods are performed on these images for segmentation process. In the post processing stage the noise has been removed from the images. From the results, it has been indicated that the FCM method gives better results compared to other methods as it has great detecting capability and less false positive rate, while, DPSO and K-means has low performance. The manual tracing of breast tumor is also carried out by radiologist from the same images.

In this paperwork Monika Tiwari et al. [8] has worked on diverse deep learning and machine learning methods. The deep learning models, Convolutional neural network (CNN), and Artificial neural network (ANN) were implemented for prediction of breast cancer. The deep learning method provides greater accuracy than machine learning. The machine learning algorithms, SVM and Random forest algorithm have provided the accuracy of 96.5% at maximum. The CNN model has given 97.3% accuracy while the ANN model has given 99.3% accuracy. The accuracy of the ANN model is more than the CNN model for the prediction of breast cancer from the images.

Ayush Dogra et al. have stated that support vector machine (SVM) based classifiers have a high level of accuracy and precision [9]. But it requires a large number of data sets for training, and needs to choose suitable kernels and parametric models for training. They have reviewed how quality of image can affect the overall performance of the CAD model. The Convolutional neural network (CNN) also gave better results in terms of accuracy and precision. The limitation presented in this work is to aim at the pre-processing stage for noise removal and contrast enhancement as well as to get high resolution data for further process.

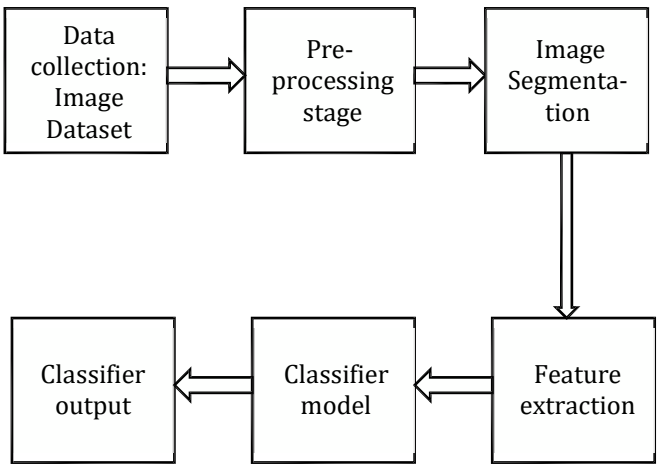
Amin Ul Haq et al. [10] have used the WDBC dataset for research work. They have proposed the machine learning, Support vector machine (SVM) technique for classification which has provided 99.71% of accuracy. The minimal

redundancy maximal relevance (mRMR) and Chi-Squared feature selection algorithms are used for feature selection. The computation time of this novel method is low compared to other methods. The dataset used for the detection has been split into two different values 0f 70% and 30% for training and testing purposes. The statistical test has been done for comparing the accuracy of this work with other previous work using MCNemar's Test for breast cancer detection.

In this study Saira Charan et al. [11] worked on 322 mammograms for detection of breast cancer. As both training and testing of the image dataset takes place, the total number of abnormal images was 133 and normal images were 189. They have particularly used Convolutional neural networks (CNN) for detection of breast cancer from the images. The masking and segmentation in the pre-processing stage improves the classification outcomes for the feature extraction process. The segmentation process helps to improve efficiency of the image. The feature extraction using the CNN provides all over 65% accuracy on the image dataset.

3. PROPOSED BLOCK DIAGRAM

Digital Image processing plays a vital role and a mammoth advancement for the application in the field of medical science. Image processing is contributed towards improving the diagnostic and clinical outcome. For accurate diagnosis and staging of breast cancer, mammography and ultrasound image processing helping to identify cancer in the early stage of development. The primary goal of this progressive review section is to review the literature on various key developments in the field of early stage breast cancer detection. A brief overview of these recent advances carried over segmentation methods, feature selection and classifier.



4. TECHNIQUES

Current section of progressive review paper discussed segmentation methods, feature extraction methods and classifiers with key merits and demerits from the previous research methods based on sensitivity to noise, accuracy, sample size and simplicity. The table I show the noticeable work contribution made from 2018 to 2021.

Table 1. Summary of segmentation methods, feature extraction and classifiers method and some of the key merits and demerits

Segmentation methods		
Techniques	**Merits**	**Demerits**
Threshold-based segmentation methods	Simple, easy and inexpensive	Cannot be used for multichannel images and it is sensitive to noise in the images.
Region based segmentation method	Easy, having multiple criterion and contain less noise in results	Time consuming method and cannot distinguish the shading of the real mammograms, as it cannot be used for noisy images.
Edge based segmentation methods	Can be used on the images having noticeable edges	Not applicable for images having smooth edges and it can also reduce the contrast of the image.
Fuzzy theory based image segmentation	Can be used to analyse images and remove noise	Cannot be used directly on gray scale images.
Artificial neural network based image segmentation	Requires less number of data and easy implementation	Number of pixels should be given.
K-means clustering method	Easy, fast and if data is recognizable, provides better result.	Requires defining the number of clusters in advance.

Darwinian Particle Swarm Optimization (DPSO)	For optimization of particular function	Less accurate
Feature extraction/selection		
Techniques	**Merits**	**Demerits**
Gray level Co-occurrence matrix (GLCM)	Second-order statistical texture features and provide better results of simple textures	Very sensitive to the size of the texture samples
Principal Component Analysis	Provides better visualized images and speed up the performance	Applicable on standardized data, Not easy to interpret
Linear Discriminant Analysis	Supervised learning, Easy to implement and fast classification	Sample size
Classifiers		
Techniques	**Merits**	**Demerits**
Convolutional Neural Network	Supervised type, High accuracy	It requires large data set
Support Vector Machine	Applicable for binary data	Cannot be applied directly on multiple data
Artificial Neural Network	Provide high accuracy	Data has to be converted into numerical form
Random Forest classifier	Has high accuracy compared to Decision tree classifier	Complex as it creates many trees
Decision Tree classifier	Classifies the data set into pre-defined classes	Less accurate compare to Random forest classifier
K-Nearest Neighbor algorithm	Simple and supervised learning	Time consuming algorithm

5. PROBLEM STATEMENT

Early-stage breast cancer detection is necessary to prevent critical causes which will lead to death. There are distinctive imaging modalities accessible for the screening of bosom cancer growth like ultrasound, mammography (x-rays), magnetic resonance imaging (MRI), computed tomography (CT-scan), etc. Other physical examinations are also performed to diagnose breast tumours. Mammograms are found to be effective for breast cancer detection and while screening any unusual results are found then tests are done directly on tissues. Doctors can also demand an ultrasound if any suspicious site is detected. As in mammograms, there are chances of getting overlapped tissues in results along with cancerous tissues which will lead to misjudgement. The ultrasound can provide a better result compared to a mammogram but has poor resolution and low contrast.

For early-stage breast cancer detection, the screening test is suggested, but breast cancer screening can cause harm in some cases. In a false positive case, a healthy person can be declared as having breast cancer. In a false negative case, a person having breast cancer can be introduced as a healthy person. During a mammogram, a patient may feel pain or discomfort. In ultrasound imaging, speckle noise can be produced in results due to which tumour identification can be difficult. The main advantage of ultrasound is not having any radiation harm but it cannot replace mammography as the outcomes are not accurate as mammograms. To get better and accurate results, we can propose a method in which the combination of both mammogram and ultrasound imaging can be used.

6. CONCLUSION

This review paper describes the work on early-stage breast cancer detection using machine learning and deep learning techniques as the early detection and diagnosis of breast cancer will assist in treatment and recovery and decrease the chances of critical situations. It is concluded from the research work that deep learning gives improvised results compared to machine learning. Deep learning is a high level sort of machine learning. It is used for the detection of tumour as well as for the classification of breast cancer images. The CNN model is used as a classifier for cancer image dataset. The CNN model provides better results with great accuracy and precision than other machine learning techniques.

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