Novel Approach of mammography image classification by Pewit filter with Deep Learning

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Abstract- Breast cancer is the most common malignancy of women and is the second most common and leading cause of cancer deaths among them. At present, there are no effective ways to prevent breast cancer, because its cause is not yet fully known. Early detection is an effective way to diagnose and manage breast cancer can give a better chance of full recovery. Therefore, early detection of breast cancer can play an important role in reducing the associated morbidity and mortality rates. Mammography has proven to be the most effective tool for detecting breast cancer in its earliest and most treatable stage, so it continues to be the primary imaging modality for breast cancer screening and diagnosis. Furthermore, this exam allows the detection of other pathologies and may suggest the nature such as normal, benign or malignant. The introduction of digital mammography is considered the most important improvement in breast imaging. Computer-aided detection/diagnosis (CAD) has been shown to be a helpful tool in the early detection of breast cancer by marking suspicious regions on a screening mammogram, allowing thus to reduce the death rate among women with this disease. These systems use computer technologies to detect abnormalities in mammograms and the use of these results by radiologists for diagnosis play an important role, once characterize lesions through automatic image analysis. The CAD performance can vary because some lesions are more difficult to detect than others, this is because they have similar characteristics to normal mammary tissue. In previous work Fuzzy rules is not optimize and used by swarm intelligence using effective fuzzy rules. The sole of the proposed work is image enhancement approach which enhanced the particle swarm optimization optimize the fuzzy rules define the effective pattern of mammography images and classified disease or not disease However, it is important to continue working in order to decrease the number of failures. Computer Aided Detection (CAD) systems play a very important role to detect mammographic abnormalities as they reduce the error rate. In this work, a novel weighted Convolution neural network with particle swarm optimization and reduce the overlapping between features and reduce the noisy learning process by convolution neural network. In proposed approach sequence of processing reduce noise and improve classification compare to other classifier with 96% accuracy.

Keywords—*Mammography, Computer Aided Detection, Fuzzy rules, Breast Cancer, Malignancy, Convolution neural network.*

I. INTRODUCTION

Breast cancer is the second leading cause of death among the women in all over the world. The proper diagnosis of the breast cancer reduces the risk of death many times. It helps the patient to relive the physical pain and mental stress. For the diagnosis of cancer mainly four methods are used that are the surgical biopsy, magnetic resonance imaging (MRI), mammography and fine needle cytology [1]. It can help decrease the quantity of passing from breast cancer among ladies ages 40 to 70. In any case, it can likewise have downsides. Mammograms can now and again discover something that looks strange however cancer isn't. This prompts additionally testing and can cause you anxiety. Now and again mammograms can miss cancer when it is there. It likewise exposes you to radiation. In this paper, the author discussed about the mammography approach. There are two types of the mammography: Mammography screening and diagnostics. The screening method is used when there is no sign or symptom of the tumor in the women [1]. The diagnostic method is used when it is not possible to diagnose in the screening process. The detection process is mainly based on the shape, age, margin, the density of the tissues in the mammograms [2]. Mammogram is nothing but an x-ray image of the breast. These x-rays are used to recognize the breast cancer in ladies which have no sign or symptoms regarding this disease. Mammography is a type of screening, which indicates the disease of breast even we have no symptoms. As there are many women, which don't even have an idea about their disease. This image helps those women and also be considered as a key factor which can reduce the death of women because of breast cancer. As this disease has more significance in the women's having age between 40 t0 70. Which is now diminishes due to mammography. Mammography is very helpful to reduce death, but it has some drawbacks too, like some time it used to show some cases which is abnormal but not cancer make a doubt on the patients and doctors, and sometimes it does not show cancer but it is actually there [2]. These are some common but important de-merits of the mammography. The whole process of identification of breast cancer is by using the mammographic image is termed as a mammogram. As breast cancer is the second leading factor which causes death among the women throughout the world. If any women caught with this disease only early diagnosis can save her life or reduce the risk rate of death. The proper diagnosis is very important to recover the breast cancer. It helps to give relief for the patients suffering from breast cancer from physical and mental stress [3]. Mammography is the medical image that uses to view inside the breast, and mammogram is the early identification and diagnosis of cancer in women. There are 4 methods for the treatment of breast cancer, i.e. surgical biopsy, magnetic resonance imaging which is termed as MRI, mammography

and fine needle cytology [4]. Mammograms are approved for the women who are suffering from breast cancer and have a threat of that.

A. Mammography

It is an image used to view inside the breast, and a process of recent identification and diagnosis of breast cancer in women. It is a type of radiograph having a noninvasive therapeutic test that make a help for the analysis and treatment of cancer. The x-ray images demonstrate the piece of the body for the evaluation of ionizing radiation to make pictures of the inner body. X-ray takes little more time, but quite useful to recognize the variations in the body. Below there are a description about the development in the mammography.

(a) Breast Anatomy: During the fetal period is created, by epidermis, a depression which forms a mammary pit on the local of mammary gland. The region where appear the mammary glands is located in left and right sides of the upper ventral region of the trunk. The breasts exist in woman and man, but the mammary glands are normally most developed in female, except in some particular circumstances related with hormonal problems. The nipple is a small conical prominence surrounded by a circular area of pigmented skin, the areola, which contains large sebaceous glands that are often visible to the naked eye. The base of the female breast, roughly circular, extends from the second rib above to the sixth rib below. Medially, it borders the lateral edge of the body of the sternum, and laterally it reaches the mid axillary line as shown in [11, Fig.1]

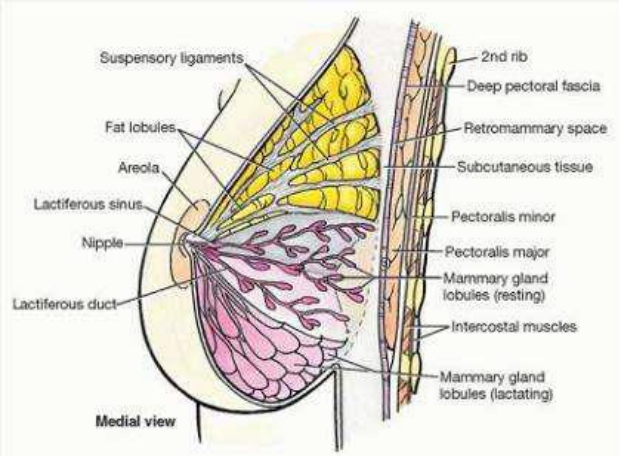


Fig.1 Breast Anatomy

B. Digital mammography: It is used to change x-rays into the mammography image of women breast by replacing x-ray film by electronics. It is also defined as full-field digital mammography, which is termed as FFDM. The function of the system is same as that of a digital camera and have the capability to give a clear image even in lower radiation. These captured images can be stored in the computer and analyze by the radiologist. The following figure.2 are the machines that are used for digital mammography.

Fig.2 Digital mammography

(a) Computer-aided detection (CAD): This system used to highlight the abnormal areas in the image captured. The abnormal areas contains are of density, mass, calcification, which may show the sign of cancer. This system helps the radiologist to take a special concern in those areas which is highlighted by the CAD system.

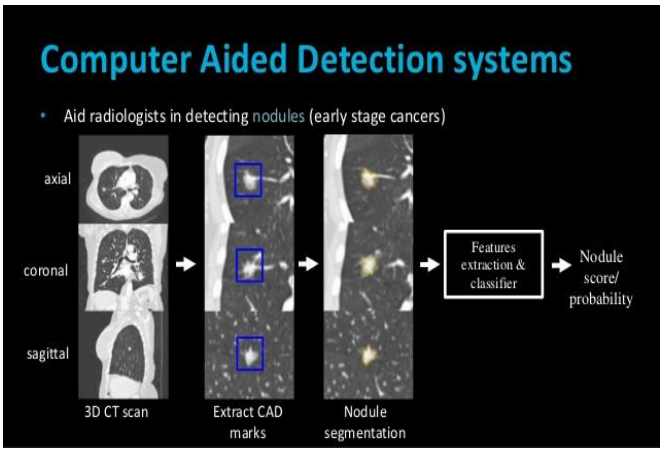


Fig.3 Cancer based Computer-aided detection

(b) Breast tomosynthesis: This system helps to give the images of breast from different angles or points in a 3-D manner. It is used to capture a number of images in 3-D. Due to this function, it is also termed as digital breast tomography, which is termed as DBT and 3-dimensional mammography. We can say that the function of tom synthesis is same as that of CT which stands for computed tomography where for creating a 3-D remaking of the body we use to take the projection of thin cuts. In spite of the fact that the radiation computation of few breast tomosynthesis frameworks is higher than the dose utilized as a part of standard mammography, it stays inside the FDA-endorsed safe levels of radiation from mammograms. A few frameworks have dosages fundamentally the same as ordinary mammography.

Fig.4 Breast Tomosynthesis Machines

C. Mammography: Advantages

The process of mammography covers the following advantages:

- These images used to recognize the tumors in the breast, which may cause breast cancer. It also enhanced the capability of a radiologist.
- Utilization of screening mammography integrates the identification of small abnormal tissues in the milk duct in the women breast, which is termed as ductal carcinoma in situ (DCIS). If we are able to recognize the tumor in early stage we can prevent the victim because tumors can be extracted out from the body if it is on initial stage. It is also used to recognize all types of breast cancer like invasive ductal, lobular cancer etc.
- As we are using x-ray films, but there is no radiation remains in the body of patient after having x-ray. They have no side effect on the body after treatment.

D. Mammography: Limitations

The limitations are described in the section below:

- Surety does not attain by mammography because images are not adequate to confirm the infection or disease. While images used for presents spots, black dots radiologist used to take another verification by advance indicative examination.
- Elucidations of mammograms can be troublesome on the grounds that a normal breast appears to be unique for every lady. Likewise, the presence of a picture might be traded off if there is powder or treatment of the breasts. In some cases, it's become very difficult to take pictures, on that case radiologist has to contrast the picture with previous examinations. From this situation is is clear that mammography is unable to represent breast cancer in every case.
- The result of mammography may also vary on the basis of expansion of breast thickness, like an increase in density creates difficulty in the process of mammography and it does not show cancer even if they have.
- The risk of breast cancer is directly proportional to the density of the breast.

There is an identification about the density of breast and noted down for the doctor to compute better result. There are some statements used to facilitate the patient having dense breast. There is another factor that affects the recognition of breast cancer in the human body by mammogram termed as a breast implants. Some implants like silicon and saline are not transparent implant and can block the view of tissue just behind them. Experienced technologists and radiologists know how to carefully compress the breasts to improve the view without rupturing the implant. The radiologists are trained for this type of situation and they can take images without harming the implant. While appointing with any doctor or radiologist it is very important to examine the professional work or performance of them especially those which have large implants. There are numbers of merits as well as de-merits of the mammogram. Mammograms are the best technique to recognize the breast cancer in the women. As we discuss above in some cases mammogram shows some abnormal activity, but it is not cancer is termed as false-positive result, because it is a false result but in a positive manner. Whereas in some cases mammogram is unable to recognize the cancer, which is termed as false-negative result. For the early detection of breast cancer and to enhance the precession rate many experiments and investigation is done on the different imaging technique. This investigation also helps to differentiate between cancer and non-cancerous breast.

II. RELATED WORK

De Oliveira et al. [1] proposed an approach which classifies the region of mass and non-mass in the mammograms. In this author uses the texture feature of the mammograms. For the analysis of features, internal mask and external mask are used. Support vector machine (SVM) is used for the classification. The result of the proposed methodology shows the better accuracy in the identification of mammograms. Abdel-Nasser, Mohamed, et al. [2] in this paper, the author introduced a method to identify the tissue abnormality in the breast. The author introduced Uniform local directional pattern which classifies the tissue patterns from the mammograms. This method work in the three-part first is to segment the rate of interest secondly extract the features and third is classification. It uses the SVM classifier to classify the features. The result of the paper shows that it works very effectively. Reyad et al. [3] in this paper, the author studied the effects of computer-aided diagnosis in detecting the various diseases. CAD uses different methods of classification of masses in the mammography. Here author studied the concept of the local binary patterns and multi-resolution analysis of mammograms. LBP is a text descriptor and it extracts the features from the region of interest. Multi-resolution features are obtained from the discrete wavelet transform. Classification of the features is performed by using the support vector machine classifier. Hussain, Muhammad, et.al. [4] introduced a method for false-positive reduction in the features of the mammograms. The author introduced the Weber Law Descriptor. WLD integrates the local information content into the histograms. In this paper multi-scale spatial WLD is used to characterize the texture microstructures. It generates the high feature space. The result of the proposed approach shows the efficiency improvement in the results. Jen et al. [5] developed a computer-aided system which detects the abnormal mammograms. In the proposed approach author extracts only five features of intensity for mass detection in the mammograms. Fore feature weight determination principal component analysis is used. The classification process is performed by using abnormality detection classifier. This classifier also adjusts the feature weight. This method improves the performance and provides the high accuracy of the system. Junior, Geraldo Braz, et al. [6] proposed a Spatial Diversity approach which reduced the false positive. In this approach, it increases the sensitivity and also reduces the procedures. It analyses the diversity

of approaches and enhances the spatial decomposition. The result of the paper shows that it is effective for the mammogram detection. Hussain et al. [7] introduced a method of false positive reduction by using Gabor feature subset selection method. In this method, texture features are used for detection of masses in the mammograms. Gabor filter is used to identify the micro-patterns of the features. It represents the multi-scale and multi-directional features also which results in the effective accuracy. SVM classifier is used for the classification. The result of the proposed method provides the effective performance in cancer detection. Chu, Jinghui, et al. [8] proposed computer-aided detection system for cancer. This method is based on the morphological enhancements and super pixel segmentation. The proposed method consists of different components. Pre-processing is based on the morphological enhancements which group the tissues in the different region. Rule-based classification is used to eliminate the unwanted region. The false positive reduction is based on the feature extraction. Support vector machine classifier is used for the classification of the features. The results proved that this system reduced the FP rate and enhance the performance. De Sampaio, Wener Borges, et al. [9] proposed a method of detection by using the genetic algorithm. This method firstly detects the density of the masses of the breast is dense or non-dense. It firstly divides the mammograms into the segments and applies the genetic algorithm which creates the texture proximity mast to the suspected regions. The next task performed by the proposed method is to reduce the false positives which are generated by the previous state. For false positive reduction, it uses the DBSCAN and a proximity ranking of the texture features extracted from the ROI. Classification of masses is done by SVM classifier. Results show that it enhances the sensitivity and reduced the false positive rate.

Costa et al. [10] proposed a method to diagnose the cancer of the breast by using mammograms. In this method, the author uses the coding method and Gabor wavelet method. These methods differentiate the mass and non-mass regions from the mammograms. LDA (Linear discriminant analysis) and ICA (Independent component analysis) method are used for the prediction of the dataset.

III. THE PROPOSED METHOD

In this section, we discussed the proposed approach and the methodology used to achieve the results. In this methodology, we use the Prewitt filter for the edge detection of the mammographic images. It works on the 3*3 convolution mask. It detects the horizontal as well as vertical edge. It is also called as a discrete differentiation operator. It is used to compute the gradient of the image intensity function. In this filter it reduces the noise from the image, then sharpens the edges of the object in the image. After this, it detects the features which have to discard and which have to maintain.

ALGORITHM USED

Step 1: Input the mammographic images.
Step 2: Apply Gray Scale on the images.
Step 3: Edge detection by using the Prewitt Filter.
Step 4: For optimization input in the PSO model.
Step 5: Apply the loop in PSO model. for each particle n in S do
Step6 : for each dimension d in D do
Step7: //initialize each particle's position and velocity
Step8: $y_{p,q} = \boldsymbol{Rnd}(\boldsymbol{y_{max}}, \boldsymbol{y}_{\min})$
Step9: $\boldsymbol{z_{p,q}} = \boldsymbol{Rnd}(-\boldsymbol{z_{max}}/3, \boldsymbol{z_{max}}/3)$
Step10: end for
Step11: //initialize particle's best position and velocity

$$\boldsymbol{z_p}(l+1) = \boldsymbol{z_p}(l) + \boldsymbol{\gamma 1_n}(\boldsymbol{p_n} - \boldsymbol{y_n}(l)) + \boldsymbol{\gamma_{2n}}(G - \boldsymbol{y_n}(l))$$

New velocity

$$\boldsymbol{y_n}(l+1) = \boldsymbol{y}_{\boldsymbol{n}}(l) + \boldsymbol{y_n}(l+1)$$

Where,
p denotes the particle index
l denotes discrete time index
z_p denotes velocity of n^{th} particle
y_p denotes position of n^{th} particle
p_n denotes best position found by n^{th} particle(personal best)
J denotes best position found by swarm(global best, best of personal bests)
$J_{(1,2)i}$- random number on the interval[0,1]applied to the n^{th} particle
Step12: $\boldsymbol{pb_n} = \boldsymbol{y_p}$
// update global best position
Step13: if $\boldsymbol{f}(\boldsymbol{pb_n}) < \boldsymbol{f}(\boldsymbol{gb})$
Step 14: $\boldsymbol{gb} = \boldsymbol{pb_n}$
Step15: end if
end for
Step 16: After optimization change in the fitness value.
Step 17: Extract the texture feature and then learns the features by using the Deep Learning method.
Step 18: Calculate the sensitivity, specificity and accuracy by confusion matrix.

A. PSO (Particle swarm optimization): The PSO is a population-based stochastic algorithm driven by the reenactment of a social mental representation rather than the survival of the fittest person. Roused by the swarm insight and probabilities speculations, this work shows the utilization of consolidating of PSO, Gaussian probability distribution functions and additionally turbulent groupings. In the process of PSO, particles are float through the hyper-dimensional search space [8]. PSO is a population based search algorithm which is based on simulation on the social behavior of birds within a flock. Variation in the position of particle in a search space is depending upon the psychological tendency of each particle to imitate the development of other. In PSO swarm consist of a set of particles where each particle demonstrate a potential solution. The position of particle is varying with respect to its own experience and of the neighbor particles. PSO is used to optimize the value of objective function. Every particle in space used to mobile to find the point where optimized function is obtained where 'z' is the position of particles in time 'h' having velocity 'u'. Every particle has its local and global best position in the space. Global best position is the position of a particle which is close to optimal value and all the particles move towards the global best position. The global position of particle will vary with the motion of particles [8].

$z_r(h) = z_r(h-1) + u_r(\mathrm{h})$……..... (1)

$u_r(h) = Iu_r(h-1) + L_1V_1\left(z_{pbest_r} - z_r(h)\right) + L_2V_2(z_{gbest} - z_r(h))$…….. (2)

Where, 'I' is the weight of inertia and L_1 and L_2 are the learning factor and V_1 and V_2 are the random values. By using equation 1 and 2 we can obtain fitness value of the feature after optimization. It is a global optimization algorithm for optimization where best solution is represented as a point or surface in n-dimensional space. It consists of time step, variation in velocity to attain globes best and local best position in the space and with the help of random terms there is an evaluation of acceleration the separate random number is created for acc. for local best and global best position in the space [8].

B. Proposed methodology: Algorithm/Flowchart

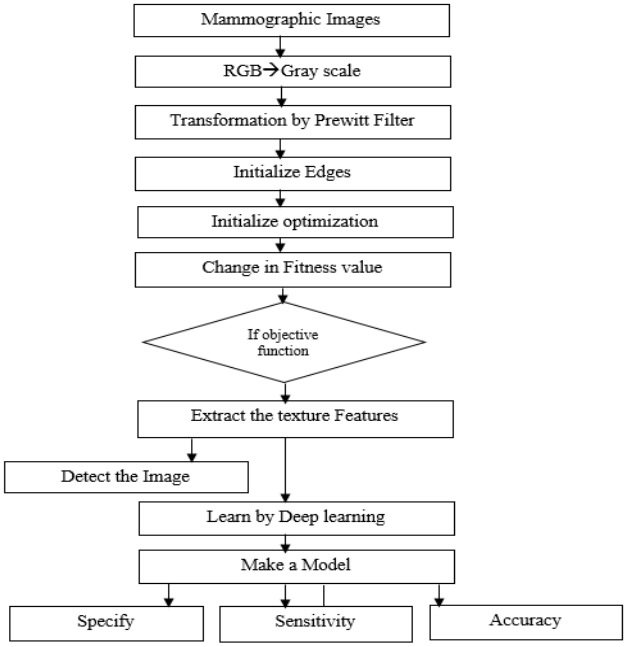


Fig.5 Proposed Flowchart

The flowchart consists of the mentioned steps that perform a specific function as per the requirement or the operation conditions of the process and is illustrated as follows:

IV. RESULTS

In order to get the formalized desired form of results, the experimental analysis has been done based on certain parameters as presented below.

(a) Database: MIAS dataset is used for performing the proposed approach on the mammograms. This dataset named as Mammographic image Analysis Society Database. This database explains the images on different factors that are background of tissue and abnormality present in the mammograms.

- Character for Background Tissue: F: Fatty; G: Fatty Glandular; D: Dense Glandular
- Severity of Abnormality: B: Benign; M: Malignant

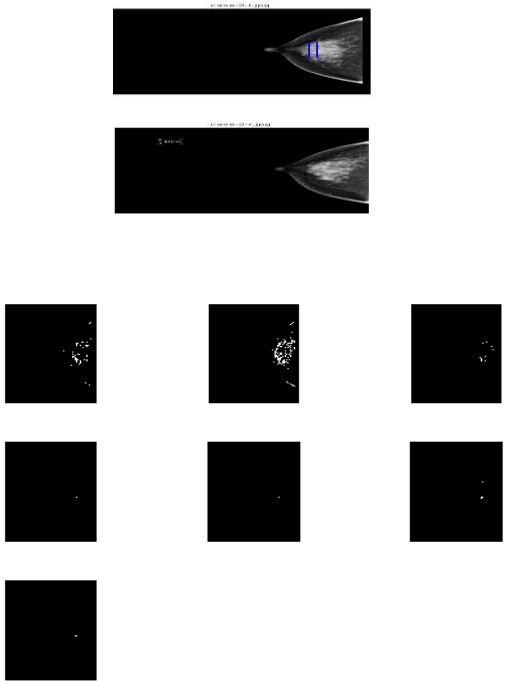
(b)Parameters: In the proposed approach performance is evaluated by using following parameters.

- Sensitivity: $\frac{tp}{tp+fn}$
- Specificity: $\frac{tn}{tn+fp}$
- Accuracy: $\frac{tp+tn}{tp+tnfp+fn}$

Here, True Positive = t_p; True Negative= t_n; False Positive = f_p; False Negative = f_n

A. Results after detection

In the fig.6 [a, b] given below shows the point base feature after segmentation and masking of mammography images. These image extract the features in different angles which is useful for classification and prediction cancer and not cancer.



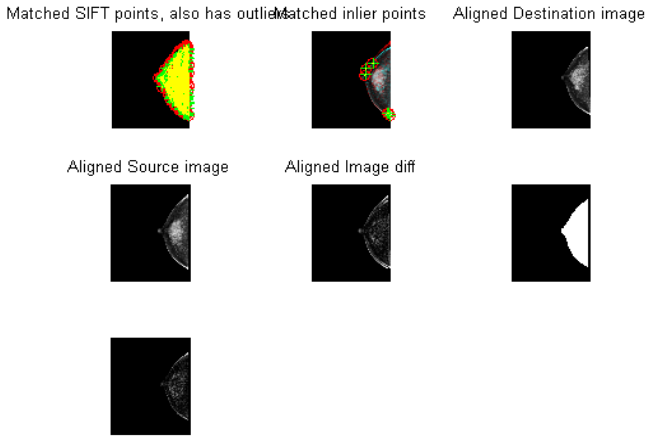


Fig.6 [a, b, c] Results Detected

B. Classification Results

The results are obtained with the help of classification based on Support Vector Machine (SVM) and Neural Networks (NN) as illustrated below:

Table.1 Result table of different classifiers

Parameters	Proposed	SVM	N.N
Accuracy	96.26	88.26	84.23
Sensitivity	92.45	79.92	75.62
Specificity	98.45	92.26	90.23

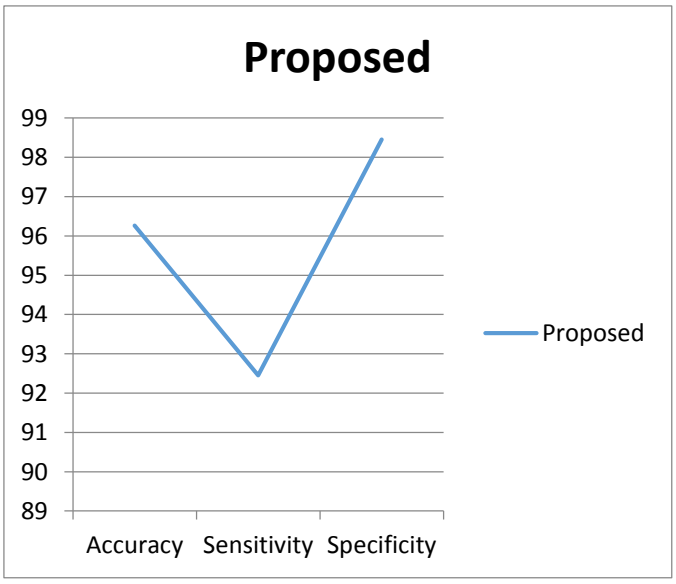


Fig.7 Proposed method results

(a) Fig.7 depicts the results of the proposed method in which x-axis shows the parameters that used to evaluate the performance and Y-axis shows the values of the parameters. In the proposed method accuracy is 96.26, sensitivity 92.45 and specificity is 98.45.

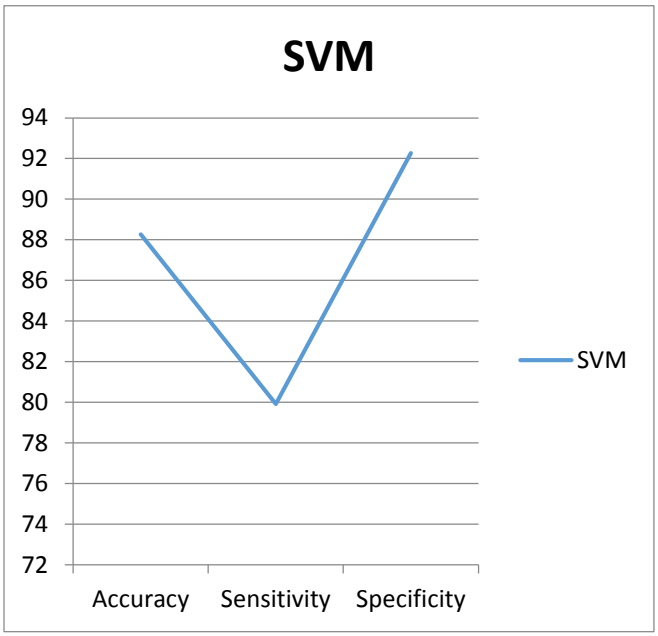


Fig.8 SVM: Proposed Results

(b) Fig.8 depicts the results of the Support Vector Machine approach in which x-axis shows the parameters that used to evaluate the performance and Y-axis shows the values of the parameters. In the Support Vector Machine approach accuracy is 88.26, sensitivity 79.92 and specificity is 92.26.

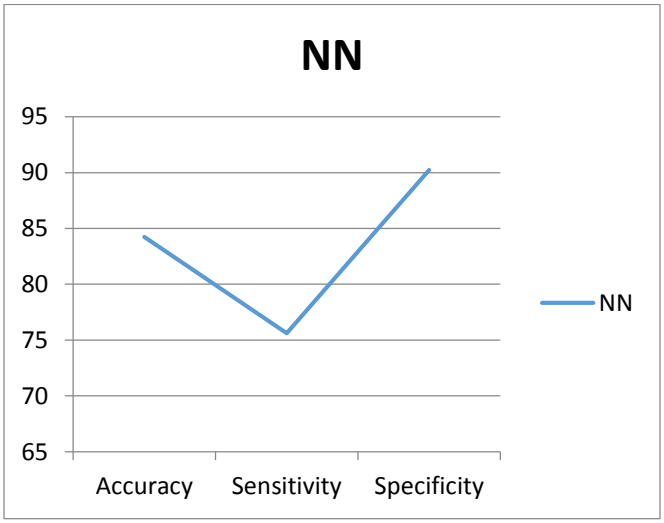


Fig.8 NN: Proposed Results

(c) Fig.8 depicts the results of the Neural Network approach in which x-axis shows the parameters that used to evaluate the performance and Y-axis shows the values of the parameters. The blue curve on the graph shows the values of the neural network on graph. In the Support Vector

Machine approach accuracy is 84.23, sensitivity 75.62 and specificity is 90.23.

C. Comparative Results

In fig.9, a comparison has been done covering the proposed results, neural network and support vector machine. The blue curve on the graph shows the variables of proposed approach, red curve represents the support vector machine and green curve represents the neural

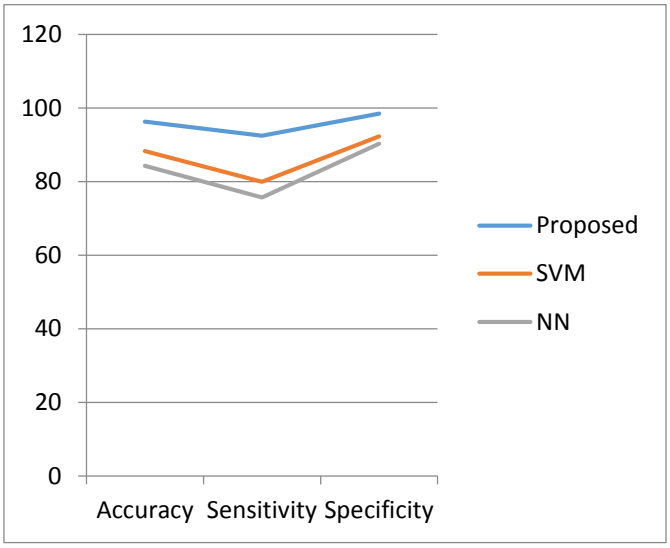


Fig.9 Compariteve Results

network. The position of the curve represents the proposed method performs effectively.

V. CONCLUSION

Mammography is the medical image that uses to view inside the breast, and mammogram is the early identification and diagnosis of cancer in women. There are 4 methods for the treatment of breast cancer, i.e. surgical biopsy, magnetic resonance imaging which is termed as MRI, mammography and fine needle cytology. Computer aided design for mammography is heavily studied problem that gives its potential for large real world impact. This field is also like others due to transitioning of hand engineered feature to feature learned in deep learning framework. While there have been many efforts to apply dep learning to the sub components of the mammography pipeline, here we are concerned with full image classification. This process gives the high resolution and relatively small ROIs but effectively designing is an end to end challenging task. In the proposed approach false positive is reduced when compare to other existing approach like SVM and neural network.

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