

# Detecting Breast Cancer in X-RAY Images Using Image Segmentation Algorithm and Neural Networks

Rasha Talib Gdeeb

Department of Environmental Engineering, College of Engineering, University of Baghdad, Iraq  
E-mail: rasha.talib@coeng.uobaghdad.edu.iq

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*Breast cancer presents a global health challenge that is endangering the lives of women all over the world. Because of this, many researches are attempting to provide an early detection technique to lessen the danger that breast cancer may cause; with a potential impact of saving 30% of the afflicted populace. Mammography, employing X-ray irradiation, serves as a quintessential modality for the identification of breast anomalies including neoplastic obstructions, discomfort, and nipple exudations. Concurrently, deep learning, a subset of artificial intelligence, has garnered momentum in the realm of breast carcinoma diagnostics. This paradigm facilitates the automated detection and categorization of neoplastic formations within mammographic imagery, as well as other radiological techniques, by learning to discern patterns autonomously without explicit algorithmic instructions. Deep learning algorithms are capable of learning to detect patterns in medical images without being explicitly programmed. This technology is being used to detect breast cancer earlier and more accurately than ever before. With the help of deep learning, radiologists can identify suspicious lesions, classify them as benign or malignant, and even predict the risk of recurrence of a malignant tumor. Furthermore, it enables the visualization of tumors that might elude unaided ocular inspection. Several types of neural network architectures, including but not limited to conventional and artificial neural networks, have been deployed in various studies for neoplasm detection, this task needs a preprocessing task depending on image processing like filtering, images enhancement, and gray levels detection to isolate and detect even the smallest areas in X-RAY images. This search uses image processing and computer vision approach to detect and recognize tumor areas in an X-RAY with the aid of neural networks to classify the danger level of the disease automatically.*

*Povzetek: Da bi zagotovili zgodnje odkrivanje tumorja na dojki, raziskava pelje tehnike za avtomatsko izbiro zdravljenja na osnovi rentgenskih slik. Metoda v treh korakih vključuje primarno pomoč, kemično obdelavo in odstranitev.*

## 1 Introduction

Breast cancer becomes one of the most dangerous nightmares threatening women all over the world, early detection of cancer increases healing of it, it can save 30 percent from infected women which is a big percentage. Dangerous of breast cancer comes from the fact that all the women do not know about it until they have a mammogram image for the breast. It can be detected personally in late stages. That means it is important to make a medical examination periodically to investigate the presence of any Cancerous lumps in breast tissue or underarm which can be an indicator for the existence of the tumor [1]. Mammogram rays are an X-RAY applied on the breast which can used to find any problems in the breast like tumor blocks in breast, pain, secretions from nipples. Mammogram rays can detect breast cancer early and decrease the death cases. mammogram imaging starts in 40 age and must done every 3 years to assure the not infection of it. In cases of Genetic disease history, it is important to take the mammogram imaging

before 40 ages in the state of early tumor detection so it increases the recovery in early stages [2].

- Mammogram can help detecting early cancers before 3 years without watching any changes on breast or any symptoms, doctors usually asks for mammogram imaging in these symptoms: Secretions from the nipples in addition (or without) breast milk [3]-[6].
- Changing in nipples shape or reverse of the nipple to inside.
- Changes in the breast skin.
- Breast tumor (all of it or some parts).
- Tumor on the lymph nodes

There are two types of x-ray imaging used which are:

- checking Imaging: here we need a periodically check to search for breast cancer for a woman has no signs of cancer infection, it is a routine

check after the age of 40's to early detection of it.

- Diagnosis imaging: here we want to diagnosis the situation by a check for a special problem in breast like feeling a tumor as example. When a woman got the mammogram image, the result appears after 24 hours with a special code giving the resulted situation which are:
- BIRADS0: this code means that the check is not completed, it needs repeating or more checking for assurance of the result.
- BIRADS1: the check result is negative, there is any signs for cancer presence.
- BIRADS2: the situation is normal and there is no cancer, and maybe there will be an existence of calcifications and benign lump in the breast.
- BIRADS3: it means the existence of benign lump; it is important to repeat the check after 6 months to make sure that the tumor has not changed to another type.
- BIRADS4: means a high probability of cancer existence, here we need to have a biopsy (a sample of a cell) by the doctor.
- BIRADS5: high probability to 90% for cancer tumor, here we need to check the tissues too.

## 2 Objective and expected research contribution

The importance of our search is to create an effective user interface that can use by doctors to detect the condition of the breast cancer and the medical treatment required. The input of the system is an x-ray image changed to an RGB image to handle with MATLAB.

Several techniques were used to solve all the problems that the image can suffer of. We can use our system to solve the wrong medical analysis for a wide range of cancer situations like breast cancer, brain cancer, and skin cancer [7]-[9].

The research objectives are summarized in the following points:

- Build an effective user interface to detect the breast cancer using MATLAB program.
- Decide and choose the best filtering methods to remove the noise of the images.
- Build a good feature extractor which can give the best and the most accurate results.

## 3 Research methods and materials

If we want to decide the situation of the cancer, we must check the size of it and if it is spreading to lymph nodes or any other parts in the body. Stages of breast cancer are:

- Stage0: known as ductal carcinoma which starts in milk ducts and do not spread to near tissues.
- Stage1: in this stage the tumor will be in a size of 2 centimeters and did not effect on lymph nodes yet.
- Stage2: the tumor is still 2 centimeters and started to spread to the near lymph nodes.
- Stage3: the tumor increases to 5 centimeters in size and starts to spread to some lymph glands.
- Stage4: the tumor started to spread to the far parts in the body like bones, liver, brain, and lungs.
- Surgery: there are several types of surgery depend on medical diagnosis and consists of tumor excision with some nearby tissues specially id the tumor size is small. Second type of surgery is Mastectomy which means removing Lobes, milk ducts, adipose tissue, nipple, areola, and some skin and maybe some muscles from the breast. Another type is removing the lymph node, removing one node may cause the tumor to stop because if the tumor affects the lymph nodes it will spread all over the body [10].
- Radiotherapy: after one month of surgery, it is important to have Specific doses of radiotherapy to kill any cancer cells, woman need from three to five courses in a week for three to six weeks.
- Chemotherapy: If there is a high risk of cancer recurring or spreading, your doctor may prescribe cytotoxic drugs. This is called adjuvant chemotherapy. If the tumor is large, the doctor may resort to chemotherapy before surgery to reduce the size of the tumor and ease its removal. hormonal therapy: Doctors resort to hormonal therapy to prevent recurrence of hormone-sensitive breast cancers. This type of treatment is usually used after surgery, but it may be used before it to help shrink the tumor to make it easier to eradicate.

## 4 Related works

Detection of breast cancer is not an easy work because it passes by several important steps, primary of them detecting the tumor place and size using classical image processing or supervised training, to increase the system accuracy some studies used image processing and conventional neural networks together. For example, Setio et al. in [7] used to extract all the features from different directions of a 3D chest CT scanning and diagnosis the medical situation using a CNN network. Ross et al.[8] converted the 3D image into 2D image where every image scattered into patch which called 2.5D view, this 2.5D view was fed into CNN to detect early cancer features which increases the accuracy of

the system. In [9] the study tries to use the transfer learning because there are several techniques faster than CNN but they suffer of accuracy like support vector machine (SVM). In medical imaging CNN needs a primary training with a special look from doctors and experts so we can make independence of this network using the transfer learning. Transfer learning suffers of the limitation of its ability to define between medical images and human organs. In study [10] the researcher used the Fractal dimension (FD), this way can define the different between cancer lumps from malignant to benign because of its geometry so in this condition using fractal geometry is fine. In this study the searcher used FA and SVM together with Box Count Method (BCM) which got the ability to catch the best results in respective sector. Then they used BCM to extract features. The FD features was got from 42 images in a dataset and processed with the SVM classifier to distinguish between malignant to benign. The accuracy of this system was 98.13%. Study [11],[12] was about finding the small and tinny tumor to predicate breast cancer in early conditions, which can reduce death rates, woman death is between 59 to 69 because of breast cancer. Here we have a challenge to detect the tumor lumps because of changes in tissue density in mammography pictures. This research used BC detection and study of early diagnosis of C using mammographic images taken by 3D MRI and the classiffy was done using machine learning.

Table 1: An interview for previous studies used for early breast cancer detection methods.

Method	Dataset	Images	Propose	Accuracy
De Cafe Model	Break His for cancer detection	7909	Deep features for breast cancer Histopathological Images categorization	80-85%
SVM,PNN ,MLP	6 different datasets	7273	Detection and diagnosis system	99.7%
CNN	Needle biopsy microscopy images	500	Computer-aided diagnosis of breast cancer	96-100%
Deep learning	Pre trained conventional neural network	927	Diagnose breast cancer in MRI images	95%
CNN-based model	Break His ,breast cancer classification challenge 2015 dataset	7909+ 43707	Classify H&E stained breast biopsy images	77.8- 83.3%
CSDCNN based approach	Break His dataset	7909	Image and patient level classification	93.2%

As shown in table (1) all the methods used has a low accuracy that is needed to early cancer detection. This research aims mainly to use preprocessing algorithms to increase the accuracy of the neural networks in breast cancer detection that can help to decrease the danger of cancer situations on females.

Pre-processing of data and combining classifiers with neural networks can help the networks to focus on the most important features than looking just into the whole image which is a gray scale image. Using classifiers can help too to detect a smaller area that can change the

decision of the stage females can got in an X-RAY image.

### 5 Breast cancer detection system structure

Our system passes across multiple stages which are:

- Reading and resizing images: as we are reading various images types which processed in MATLAB as matrixes, these images must be in the same size to multiply with masks or to be passed to a neural network or classifier.
- Thresh-holding the sized image because we do not want the complex textures, the image will be converted to a binary image to extract cancer parts in the image from the background.
- Using wavelets to extract edges which have the maximum sharp value which define the cancer position and the important area around it.

Create geometric matrix to create some biometric calculations can define the different values of cancer

- Load the train set and train the neural network.

After resulting all the features, it will be connected in the database with the suitable therapy, the first aim using feature extraction is speeding the processing operations so we don't need to compare input image with all images which may be time and memory consuming. Here we just extract features and choose the points the most important in an image and compare it with saved data which will increase the speed of the system.

Figure (1) shows the main steps used in this research for breast cancer detection:

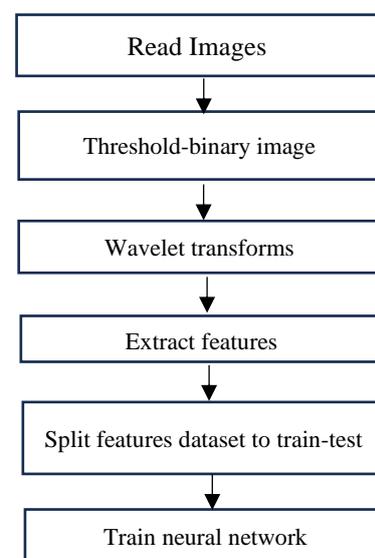


Figure 1: Steps of proposed method

The main metric values we will calculate are:

- Contrast: it is a standard shows a ration can be shown for the tones of the images, this ratio

can differentiate all the image land marks like textures, highlights, shadows, colors and clarity in a photograph.

- Correlation: this standard is used just for non-contact process which works fine with flexible materials.
- Energy: this standard is used specially to measure any changes in the image on a local position. It is the change of one or more of the image specifications like color, brightness and magnitude of all the pixels in a local area. It works fine with the edges in the images which can help with image compression as example which are the hardest position to be compressed. Edges refer to a gradient of color over all the image.
- Homogeneity: it is a statistical standard which means the most frequently colors can be got to gather together in single populations which are identical.
- Mean: it is the average of a set of values, it is used in a wide range in mathematics and statistics, this mean computed in various way as the work and the result required, it can be a simple arithmetic mean, a geometric mean, and the harmonic mean.
- Standard deviation: it is an important standard used to compute similarity. The standard deviation computes the number of variations of a set of values. If the values are close to the mean that means we can call it an expected value of the set. High values of this standard mean the values are spread over a wide range.
- Mathematically, the standard deviation of a sample or a number, a statistical population, and a dataset is the square root of its variance.
- Entropy: it is a mathematical calculation that defines how affecting transmitting data across a noisy channel. It can quantify all the information as a random variable, and it make the calculations using probability values.
- It is used on a wide range in deep learning and machine learning where it can perform features selection, building decisions trees, and fitting the classification models, which are needed too much for machine learning.
- RMS: means the square root of the mean square.
- Variance: it is a statistical indicator of how far the numbers are in a dataset and how they spread in a special space, it defines how far are the points from the mean of the subset that point belongs to. It is used by both analysts and traders to determine volatility and market security.

Smoothness: this standard is calculated to estimate the smoothing of data, it is called to the weighted averages of observation, smoothing is used to decrease the random negative and

- positive values effects by inserting them in partially offset each other.
- Kurtosis: it is a statistical measure used to describe distribution of data points in a dataset. When we have low kurtosis state then we can find that the Distributions are less extreme than the tails of the normal distribution. In another hand, if we have a high kurtosis that means we will face occasional extreme returns (either positive or negative),
- Skew ness: it is a measure of how the distribution is symmetric. We will have a symmetric condition when the positive and the negative sides are mirrored. This skew ness will be zero when it is stacked in the center.

The first and main step for this algorithm is performing an image segmentation, this means extracting specific color levels from the image. This task begins with filtering an image to remove noise and extracting edges from the image then performing the Gaussian mixture model that can isolate areas infected inside the image with more accuracy, dividing the image into two important areas that are edge-split. This result is passed then into wavelet transform that can define edges more accurate especially for small areas. Mixing GMM with wavelet transform enhance detecting of small edges that are important to detect cancer. Detecting very small edges can help to define which stage is the disease is that can led for another cure task. Figure (2) shows steps of image segmentation.

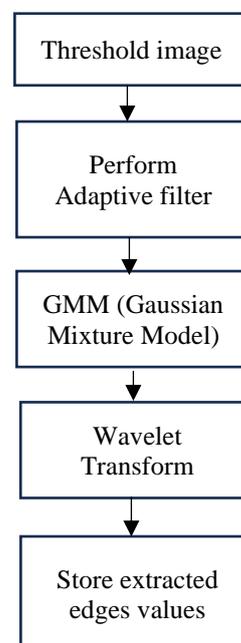


Figure 2: Image segmentation task

### 5.1 The median filter

Pulsed noise is one of the most common types of noise that is found in medical images due to the frequencies on which medical images work. This noise is also known as salt and pepper, which results from unstable voltage values. This noise causes fixed pixel values that may be white with a value of 255 or black with a value of 0. [13] The relationship expressing this noise can be written as see in Eq. (1).

$$x_i = \begin{cases} 0 & \text{with probability } p_n \\ 255 & \text{with probability } p_p \\ \varphi_i & \text{with probability } 1 - (p_n + p_p) \end{cases} \quad (1)$$

Where  $x_i$  the distorted pixel in the image and  $\varphi$  is the value of the pixel and  $p_n, p_p$  probability of pixel affected with salt and pepper which is half of noise value between 0 and 1. Filtering algorithm may be linear or nonlinear. In linear form, we add the filter to all pixels without looking if the pixel noisy or not so it is not active and result effects on noisy and non-noisy pixels. In another hand, non-linear filtering we have two stages in filtering, first we detect the noisy pixel and then we filter the noisy one and keep save pixels values. One of these filters is the average filter which takes the average of pixels and change the noisy pixel with its value. It can remove the salt and pepper noise and keep all the edges save.

There are several types for this filter like standard median filter (SM), and another modified center weighted median filter (CWMF), tri-state median filter (TSMF, progressive switching median filter (PSMF), and adaptive progressive switching median filter (APSMF)[15]-[17].

To evaluate these filters performance, we need to calculate (PSNR) as seen in Eq. (2) and Eq. (3):

$$PSNR = 10 * \log_{10} \frac{255^2}{MSE} \quad (2)$$

Where:

$$MSE = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N [I(i,j) - \overline{I(i,j)}]^2 \quad (3)$$

Where  $M, N$  the size of image and  $I$  pixels of main image and  $\overline{I}$  pixels of filtered image.

### 5.2 Adaptive Median Filter

This type of filters can detect and remove noise too, the window is an adaptive one so we can increase the size of the window if some conditions are not met, the the condition met then filtering will be done using the normal size of the window [18].

### 5.3 Gaussian mixture model

This classifier is a predictive classifier with than one feature for each data point, this algorithm depends on a classification way like that in K-means. Equation defines how this mixture works is seeing Eq. (4) and Eq. (5):

$$f(x) = (1 - \pi)g_1(x) + \pi g_2(x) \quad (4)$$

And the Gaussian mixture:

$$g_j(x) = \varphi_{\theta_j}(x), \theta_j = (\mu_j, \sigma_j^2) \quad (5)$$

see in Figure 3

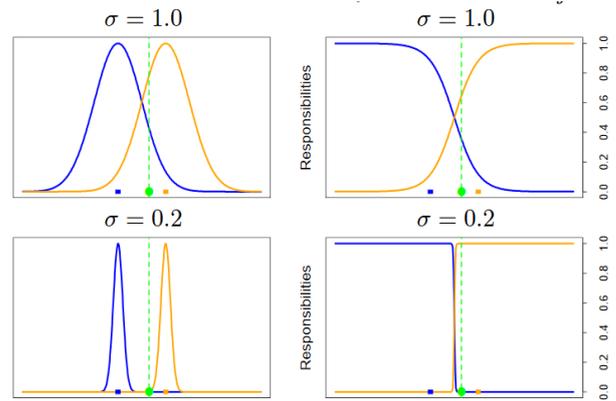


Figure 3: Gaussian mixture class decision making.

These left plots show a density of two Gaussian functions  $g_1(x), g_2(x)$  with blue and orange colors and the green point  $x = 0.5$  defines the class of it. The right plot shows the referenced densities which called the responsible objects and defined in Eq. (6) and Eq. (7):

$$g_1(x) / (g_1(x) + g_2(x)) \quad (6)$$

$$g_2(x) / (g_1(x) + g_2(x)) \quad (7)$$

These objects are responsible of every cluster for the reference point, in top plot the standard deviation is 1 and 0.2 in the bottom. The EM uses these objects to classify and soft assignment to the two clusters. When the standard deviation has a high value, these objects will equal to 0.5, but when the standard deviation gets close to zero these responsible objects will become one and the points will move to the center of the class belongs to and became zero to another clusters [19]

### 5.4 Wavelets transform

When we look to the images, we can find it consists of a group of connected areas with likely structure and a group of gray levels gathered together to create objects. If these objects are small or have a low constraint, we need to examine it in a high accuracy level, in same

way, if these objects are big or has a high constraint, we need a sharp show for It [20],[21].

## 5.5 Artificial neural network

Artificial Neural Network was created to let computers to think and act like human brain does. So, the network can understand the working flow and makes decisions [12-17]

In the case of human brain, we can calculate up to nearly 1000 billion and each one has an association point somewhere with the nearby neurons. The human brain stores data as a distributed system and each cell has a part of this data. When we need to recover it then each cell sends a part of it to be collected so that it is a parallel processing system. Figure 4.shows the three main layers the neural network consists of.

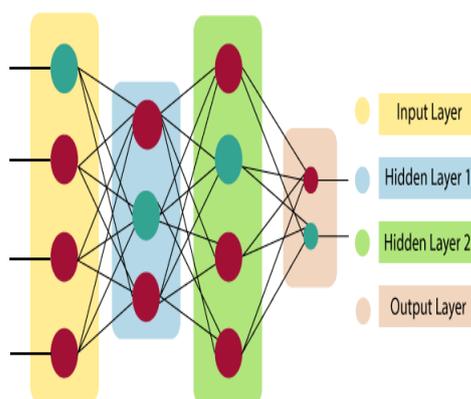


Figure 4: Layers of a neural network

The main three layers in any ANN are:

**Input Layer:**

This layer is the first layer and has to accept all the data entered by the programmer, this data may be of any type and form, binary data or float or integer...etc.

**Hidden Layer:**

Has the job of connecting between the inputs and the outputs, all the calculations the neural network does are in this layer so it can change weights and learn the pattern or the features of the inputs.

**Output Layer:**

The last part of the ANN which has the job of resulting the output depending on the hidden layer calculations.

Any neural network has a transfer function used to calculate the output as mathematical equation by multiplying each input with its weight and adding a constant called the bias. Eq. (8) defines this mathematical task.

$$\sum_{i=1}^n W_i * X_i + b \quad (8)$$

This weighted input will define which output node will fire a result as its importance in the network at all, the fire operation needs an activation function and there are

several types of activation functions like sigmoidal function the most famous and used functions.

ANN are widely used because of its advantages and the accuracy of its results; the most important advantages of ANN are:

- The ANN have the ability to work as parallel processing system that can perform more than one task in given time.
- The ability of sharing and saving data in all the network and if one part of this data disappear the network keep working.
- The ANN has the Capability to work with no requirement of pre-information about whole situation.
- The ANN has the ability to remember all the situations it trained to so it must feed with all the examples required or may it give a wrong output.

Just as artificial neural networks have advantages, it suffers from some disadvantages which are:

- We do not have a global view of the network structure, we just have to feed it with the inputs and verify the output by experience, trial, and error [18-20].
- The ANN do not give us how it produces the output or why, it just gives a testing solution.
- ANN needs a good hardware computing system with parallel processing.
- The ANN is difficult to show the hidden and issue states because of numerical data dialing with.

After entering inputs, each input will be multiplied with its corresponding weight, these weights may change or not corresponding to the activity of the neuron and the relation with other neurons.

These networks need a bias factor to keep the weighted sum not zero, so it is added to each neuron calculation task. Bias can scale up the system response. Usually, the bias weight is equal to 1 and inputs of the network can vary from 0 to positive infinity. Then the output of this stage is passed to activation function. As shown in Figure 5.

For controlling the network to get the desired output we need to use an activation function. Activation functions may be linear or non-linear. The most used transfer functions are Tan hyperbolic sigmoidal activation functions.

In binary function, the output has just two values, 0 or 1, we get this value by using a threshold value. Any value above this threshold will be 1 else it will be 0.

The Sigmoidal Hyperbola function is one of the musts used functions and has a shape of curved "S". The mathematical function for this activation function is defined as in Eq. (9):

$$F(x) = (1 / (1 + \text{Exp}(-ax))) \quad (9)$$

Where a is a constant defines how step the function is working.

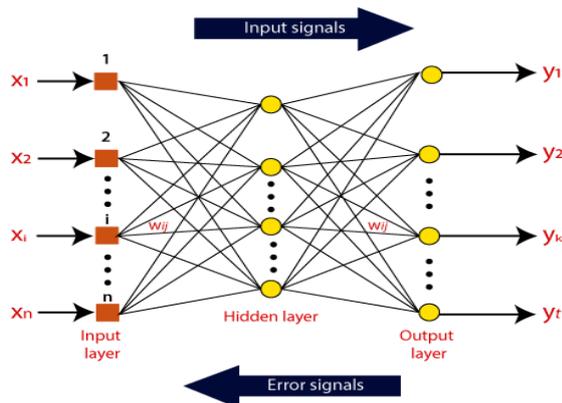


Figure 5: Working manner of a neural network

## 6 ANN types

There are several types of artificial neural networks as the tasks required of these networks to do. We have the perceptron neural network, Adeline and Madeline neural networks and the most recent up to date conventional neural networks and recurrent neural networks. Whatever the type of the ANN they are classified into two main classes which are [22-23]:

- **Feedback ANN:** this type of network uses the output computed to generate an error signal to verify how the ANN works so the network will give us the best results. This network first created by university of Massachusetts and used to solve the optimization problems for atmospheric research
- **Feed-Forward ANN:** this is the classical neural network one input and output layers and one or more hidden layers, this type of networks suited to work fine with pattern recognition systems with high accuracy results. The Tasks of activation functions

It's a traditional function that tells the neuron what is the required output, like true or false, yes or no. this activation function maps the output of the neural network between several types of outputs, may be in the range of  $[0,1]$  or  $[-1,+1]$ .

- We have two main types of transfer functions, linear and non-linear activation functions.

## 7 Results and discussion

First of all, we need to read the wanted image and filtering it with adaptive filter for the three colored layers of the image, we need to change the image to uint8 form so the gray values will be between 0 and 255 level.

After that we will run GMM, we choose two regions (affected with cancer or not), and two GMM components, we choose the number of iterations for GMM equals to 10, and then we multiply the image to increase its light levels.

We will then extract the features of the image using "gldm" command.

Network used in this research was a perceptron neural network with 13 inputs that accepts the features extracted from each image, and has 3 outputs that responds for one of the three main states of the cancer which are Benign, Malign, and normal. Where the neural network has one hidden layer. The weights initialized to be close to 0 to avoid the problem of wrong values can be achieved after training. Figure 6 shows a flowchart of ANN used in this research:

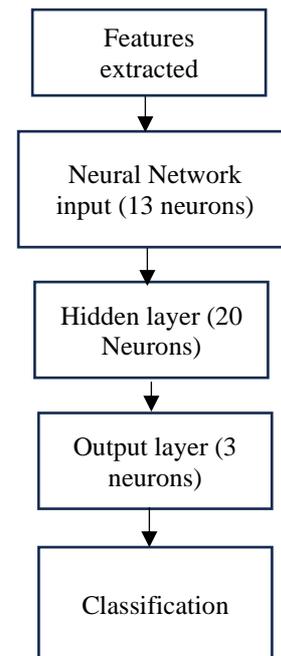


Figure 6: Classify using neural network

The model used was a new model, no pre-trained models were used for the task of cancer detection. There are several studies that aims to use conventional neural networks to detect breast cancer. But these systems need more computation power and more time for training compared with image processing and ANN methods.

Next step is training the model on the images in the dataset. The dataset consists of 200 images of each class which are Benign, Malign, and normal split into 3 files each of them was labeled as 0,1,2 for each class. Images of the dataset were saved with the form of gray scale color with the accuracy of 8-bit color (means the gray scale is between 0 and 255). This dataset was taken from Kaggle website (<http://www.kaggle.com>). We will feed the features resulted after changing it to a vector to a neural feed forward network this will result the index of the cancer in all images.

Figure.5 shows an X-RAY image of a breast, in this image we can see that the background is black and the tissue is gray while the cancer position is in white color. This image needs to be enhanced to detect the cancer area using the adaptive median filter. This is clear in Figure.6 and Figure .7.

The proposed system classified our dataset into three classes, the dataset studied consist of 20 images of each class, the system trained using GMM and classified

with k-means and SVM. The system performance was stated using accuracy, sensitivity, specificity, and another statistical calculation defines in Eq. (10-15) below.

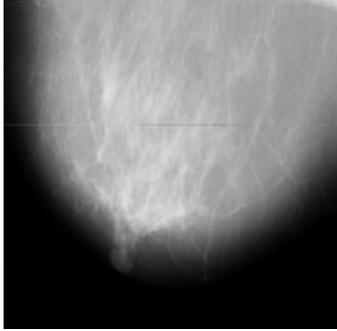


Figure 6: A breast X-RAY image

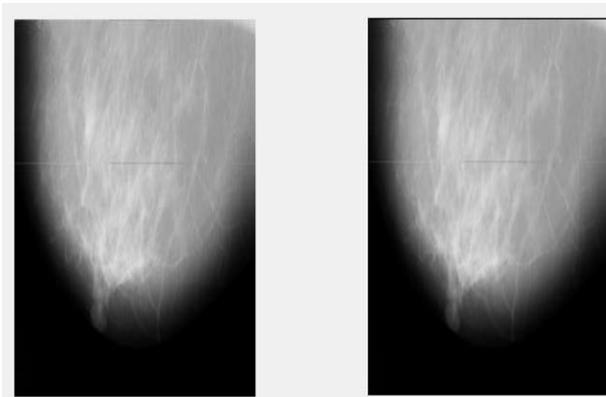


Figure 7: Using adaptive median filter

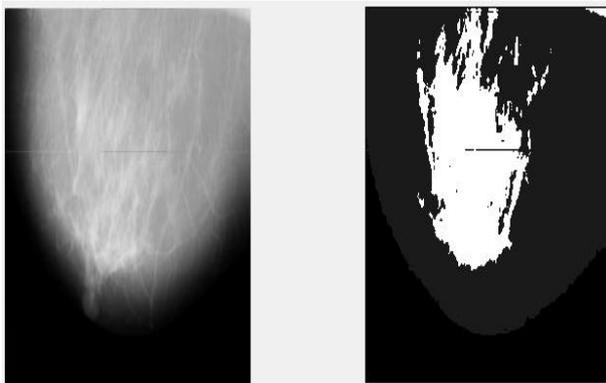


Figure 8: Detecting cancer position using K-means and Gaussian mixture

$$\text{accuracy} = \frac{C_p/G_p + C_N/G_N}{G_p + G_N} * 100 \quad (10)$$

$$\text{Miss classification rate} = \frac{C_p/G_p + C_N/G_N}{N} * 100 \quad (11)$$

$$\text{sensitivity} = \frac{C_p/G_p}{C_p/G_p + C_p/G_N} * 100 \quad (12)$$

$$\text{specificity} = \frac{C_N/G_N}{C_N/G_p + C_N/G_N} * 100 \quad (13)$$

$$\text{false - positive ratio} = \frac{C_N/G_p}{C_N/G_p + C_N/G_N} * 100 \quad (14)$$

$$\text{false - negative ratio} = \frac{C_p/G_N}{C_p/G_p + C_p/G_N} * 100 \quad (15)$$

where  $C_N, C_p$  counted positives and negatives,  $G_N, G_p$  are global positives and negatives. Table 2. Show the results for the system.

Table 2: Statistical measures of dataset

Calc.	database
Accuracy	98.56%
Miss classification rate	1.44%
sensitivity	97.66%
specificity	98.46%
false-positive ratio	3.016%
false-negative ratio	1.68%

A false positive error, or false positive, is a result that indicates a given condition exists when it does not. For example, a pregnancy test which indicates a woman has cancer when she is not, and as shown in table (2) this error is a small error.

A false negative error, or false negative, is a test result which wrongly indicates that a condition does not hold. For example, when a cancer test indicates a woman has no cancer, but she has. It is an important error that must be taken into mind. And the table (2) above shows that this error was too small which means the high performance of the model.

## 8 Applications and Implications

The method proposed in this research is an important way to define between several types of breast cancer stages. This is important for several reasons. The accurate detection of cancer edges used in this method gives more accurate split between stages of cancer, and then the decision might be varied between chemical aid or eradication which can make a difference.

In addition of that, this method is easy to be used in any clinic or hospital because the development of devices gives them the ability to give the output as a jpg image than can be passed into our application and helps to get an early detection of the cancer.

The study's findings indicate that using a combination of expert judgment and machine decision-making can provide more accurate outcomes and assist clinics and doctors avoid making mistakes in their judgments.

The main challenge of using this application is that the dataset could be larger with time that can cause for more learning time and more computation power. The bigger dataset the more accuracy can we have. The other challenge that some X-RAY images do not have JPG form but other forms that could not be used in our application.

## 9 Discussions

Compared with previous studies, the proposed method gives a higher accuracy for detection and classification of the disease, showing the importance of merging classifiers with neural networks to enhance the total accuracy for a tumor detection system. This is because the classifiers can help the neural network to focus on the most significant and important features in the image resulted by the classification task. The research focus is also on the importance of the pre-processing stages depending on image processing like filtering and morphological operations that helps the system to give better isolation for the infected areas. The obtained accuracy of 98.56% can be further increased by using several types of classifiers like SVM or decision trees combined with more advanced up to date conventional neural networks (CNN's).

## 10 Conclusion and recommendations

- 1- We recommend using the proposed system to work in hospitals as an automated auto cancer detection system because of the high accuracy and speed.
- 2- We recommend encouraging the governmental establishments to the practical conversation into automated systems because of high death levels caused by medical analysis.
- 3- We recommend using the system to early detection of breast cancer; this system is active so women can use it even at home after getting the cancer ray image.

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