ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016

National Conference on Digital Signal Processing, Information and Communication Engineering

Govt. Polytechnic College, Kasaragod

Vol. 5, Special Issue 4, November 2016

A Review on Image Acquisition Techniques and Algorithms for Breast Cancer Classification Using Digital Images

Nimmi Sudarsan[1], Nandakumar Paramparambath[2]

Student, Electronics and Communication Department, NSS College of Engineering, Palakkad, India [1]

Professor, Electronics and Communication Department, NSS College of Engineering, Palakkad, India [2]

Abstract: After lung cancer, breast cancer is the leading cause of cancer death in women [3]. Prominent in women above 40 years, breast cancer is also seen in young women and men. The only way to diagnose breast cancer is to classify tumors into malignant and benign tumors. There should be a reliable diagnosis procedure to distinguish between these tumors. But even experts find it very difficult to distinguish tumors. This paper presents a review on the breast image and feature acquisition techniques as well as the algorithms used for breast cancer classification into benign and malignant tumors.

Keywords: Sonography, Scintimammography, Ductal Carcinoma, Microcalcifications

I. INTRODUCTION

The American Cancer Society's estimates [10] for breast cancer in the United States for 2016 are: 1) about 246,660 new cases of invasive breast cancer will be diagnosed in women. 2) About 61,000 new cases of carcinoma in situ (CIS) will be diagnosed (CIS is non-invasive and is the earliest form of breast cancer). 3) About 40,450 women will die from breast cancer... Hence automation of diagnostic system is needed. There are several image acquisition techniques and machine learning algorithms for detecting survivability of cancers in human beings. This paper summarizes these image acquisition techniques and machine learning algorithms in detecting cancer in human. In this survey section 2 gives the information of various image acquisition techniques used today. Section 3 specifies about different machine learning algorithms.

Breast cancer is caused when the breast cells start to grow faster and invade neighboring tissues of the body. Mammography is one of the most effective and popular modalities presently used for breast cancer screening and detection. Efforts have been made to improve the accuracy of breast cancer diagnosis using different imaging modalities. Ultrasound and magnetic resonance imaging have been used to detect breast cancers in high risk patients. Recently, electrical impedance imaging and nuclear medicine techniques are also being widely used for breast cancer screening and diagnosis. Tissue microarrays (TMAs) facilitate the survey of very large numbers of tumors. However, the manual assessment of stained TMA sections constitutes a bottleneck in the pathologist’s work flow [13].

The breast is composed of identical tissues in both men and women, and hence, breast cancer also occurs in men. Breast cancer incidence in men is approximately 100 times less than in women, but men with breast cancer are considered to have the same statistical survival rates as women. Breast cancer patients can considerably benefit from adjuvant therapy. Neoadjuvant chemotherapy for breast cancer patients with large tumor size is a necessary treatment [14]. However, aggressive adjuvant therapies are costly, can lead to potentially serious side effects and thus are only given to patients that are at a high risk [11]

II. IMAGE ACQUISITION TECHNIQUES

This section presents a review of the various image acquisition techniques used for breast cancer detection.

A. X-RAY MAMMOGRAPHY

Mammography can be describedas the most common method for capturing breast images. It mainly uses low-dose amplitude-X-rays to examine the human breast. Only the cancerous masses and calcium deposits appear brighter on the mammogram.

As a result this method is good for detecting Ductal Carcinoma In Situ (DCIS) and calcifications. Mammography can be used to detect early stage breast cancer before the lesions become clinically palpable. As described in [2], mammography has helped to decrease the mortality rate by 25%-30% in screened women when compared with a control group after 5 to 7 years.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016

National Conference on Digital Signal Processing, Information and Communication Engineering

Govt. Polytechnic College, Kasaragod

Vol. 5, Special Issue 4, November 2016

Randomized trials of mammographic screening have provided strong evidence that early diagnosis and treatment of breast cancer reduces breast cancer mortality.

Asymmetry between the left and right mammograms of a specified subject is a main sign used byradiologists to diagnose breast cancer [7].The BI-RADS [23] description of asymmetry indicates the occurrence of a greater density of breast tissue not including a distinct mass, in one breast as compare to the corresponding area in the other breast. The contour outlining the lower half of the breast is important for the quantitative assessment of breast aesthetics. Based on this inferior breast contour, relevant morphological measures, such as breast symmetry, volume, and ptosis, can be determined [12].Fig. 1 shows a mammogram image, with different breast tissues and Fig 2 demonstrates the illustration of different breast regions when the breast tapers off. The breast boundary can be obtained by partitioning the mammogram into breast and background regions. The extracted breast boundary should adequately model the skin-air interface and preserve the nipple in profile. However, skin-line region in mammograms where the breast tapers off is normally very low in grey-level contrast. It is caused by the lack of uniform compression of the breast, near the breast edge region. This effect decreases the visibility along the peripheral region of the mammogram and makes it difficult to preserve the breast skin-line and to identify the nipple position as shown in Fig. 2.It is very difficult to detect cancer in the early stage using mammographic screening.

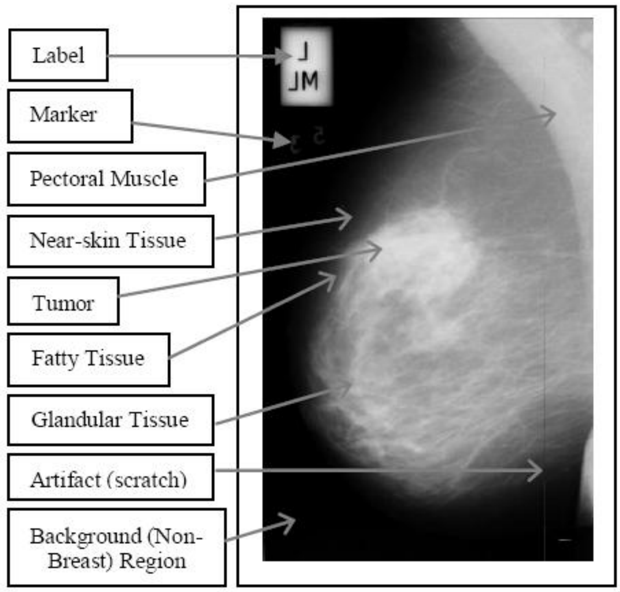

Fig. 1 A mammogram image composes of the image background, label, marker, artifact (scratch), near-skin tissue, fatty tissue, pectoral muscle and denser glandular tissue [9].

However, additional screening tests may reduce the death rate from breast cancer. The mammography screening test has been shown to lower the death rate in randomized controlled trials conducted with the general population. Mammographic imaging has proved to be scientifically more suitable for screening, and hence, may be used for general screening. Patients with abnormal breast findings were screened using mammography, sonography and magnetic resonance (MR) mammography. Carcinoma in situ was diagnosed in 78.9% and 68.4% of patients using mammography and MR mammography, respectively. A combination of all three diagnostic methods performed better in detecting invasive cancer and multifocal disease. However, the sensitivity of mammography and sonography combined was identical to the performance of MR mammography (i.e. 94.6%).

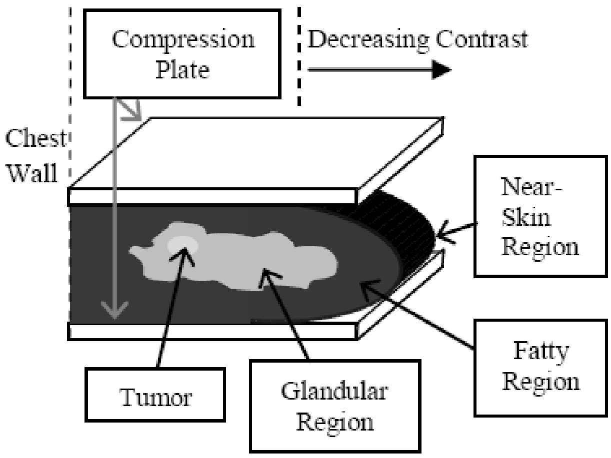

Fig. 2 Illustration of different breast regions when the breast tapers off [9].

B. BREAST ULTRASOUND

Ultrasound imaging is used as an adjunct tool for detecting the location of the suspicious lesion. The ultrasound transducer directs high-frequency sound waves into the breast tissues and detects the reflected sound waves which are then used to display 2D images. As the sensor is moved over the breast, continuous real-time images can be captured. Ultrasound can be used instead of mammography for clinical examination in the assessment of both palpable and impalpable breast abnormalities. Ultrasound screening in asymptomatic women causes unacceptable false positive and false negative outcomes. Hence, there is little evidence to support the use of breast ultrasound in breast cancer screening.

Mammography cannot thoroughly detect cancers in dense-breasted women. The mammography with an automated whole breast ultrasound (AWBU), for women with dense breasts is found to be much better. A study by Kelly et al showed that 87% of cancer detections added by AWBU

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016

National Conference on Digital Signal Processing, Information and Communication Engineering

Govt. Polytechnic College, Kasaragod

Vol. 5, Special Issue 4, November 2016

were found in the 68% of studies in women with dense/very dense breasts. Thus it can be concluded that AWBU resulted in significant cancer detection improvement compared with mammography alone. Kopans has suggested that sonography should always be used with mammography or other imaging techniques. It alone will not be able to detect lesions accurately. Breast cancer is quite common among Japanese women who are in the age of 40s with small and dense breasts. The performance of ultrasound was similar to that of mammography in detecting breast cancers in these women. By combining mammography and ultrasound, we can form a suitable method for breast screening in Japan. A recent study on the efficiency of whole breast ultrasound based on BI-RADS final assessment categories in women with mammographically negative dense breasts has reported that ultrasound is useful for dense breast classification and diagnosis.

C. BREAST THERMOGRAPHY

The metabolic rate achieved by a cancerous and pre-cancerous tissueis high resulting in growth of new blood vessels supplying nutrients to the fast growing cancer cells. This may result in the temperature of the area surrounding the pre-cancerous and cancerous breast tissue to be much higher when compared to the normal breast tissue temperature. Studies on human breast confirms that it exhibit a circadian rhythm, which can be well reflected in its physiology. It is also said that these rhythms, associated with malignant cell proliferation, are non-circadian. By examining the relationship between breast skin temperature and breast cancer, measurable changes were observed in skin temperatures between clinically healthy and cancerous breasts. The cyclic variation in temperature and vascularization of the normal breast thermograms under a controlled environment were studied. The results of this study help in the analysis of normal and abnormal breast thermography.

Breast thermograms today are widely used for the accurate detection of breast cancer. Thermography is said to be a promising screening tool because it is able to diagnose breast cancer at least ten years in advance. However, both analysis and interpretation of thermograms depends on analysts.

D. MRI

Magnetic resonance imaging technique involves the usage of the hydrogen nucleus (single proton) for imaging purposes because this nucleus is abundant in water and fat. The magnetic property of the hydrogen nucleus is used to produce detailed images from any part of the body. The technique behind MRI is: The patient who is examined using MRI is placed in a magnetic field and a radio frequency wave is applied to create high contrast images of the breast. In dynamic contrast enhanced-MRI (DCE-MRI), a contrast agent is injected before the images are captured. This technique has been found to be more sensitive than mammography.

Breast MRI for the early detection of breast cancer is a widely used imaging modality. Recent studies reveal that MRI can dramatically improve the yield of screening certain at-risk populations. Further work may be performed to clarify the role of breast MRI in the early detection of breast cancer. Recent work on breast MRI with 3 Tesla magnets showed that MRI had a higher spatial and temporal resolution and a better signal to noise ratio.

By applying the present state-of-the-art imaging modalities, namely MRI, magnetic resonance spectroscopy (MRS), nuclear imaging, and optical imaging, for precise identification of human breast tumors and their use in monitoring chemotherapeutic responses has been discussed. MRI helps in investigating vascular changes associated with neoangiogenesis. It is popular for the diagnosis, and can also be used to assess tumor response to treatment. Recently developed contrast agents and improvements in measurement and analytical methods will help the use of MRI in investigating the vascular dependence of tumor growth and the activity of vascular-directed therapies.

Several demonstrations on clinical studies reveal that malignant tissues have elevated levels of choline-containing compounds, suggesting that these compounds may serve as non-invasive markers for detecting malignancies. In vivo non-invasive MRSI uses equipment that is almost identical to the normal MRI apparatus but with specific sequences for spectroscopic signal acquisition to visualize the total choline content in the breast. MRS improves the specificity of MRI further, and it can predict response to therapy and/or evaluate very early response to chemotherapy. In a study using MRS, the specificity was observed to be 87.5% which was significantly higher than that obtained using MRI (62.5%).

Novel contrast agents are being developed to provide more sensitive and more specific discrimination of benign from malignant lesions. MRS and MRI are rapidly becoming standard capabilities of clinical MR systems with magnets 1.5 Tesla or stronger. The promising results from multiple institutions reported so far suggest that MRS, along with MRI, can improve the clinical assessment of breast cancer in the future.

Numerous multicenter trials may still be needed before these new techniques can be widely used to guide diagnostic decisions and to predict response to therapy. Brain and prostate cancers also exhibit increased choline levels, and hence, MRS is suitable for assessing these cancers.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016

National Conference on Digital Signal Processing, Information and Communication Engineering

Govt. Polytechnic College, Kasaragod

Vol. 5, Special Issue 4, November 2016

In elastography, a periodic motion is generated by a mechanical shaker to one side of the breast and the resulting displacement field inside the breast is captured by MRI to determine the elasticity parameters. This technique relies on MRI's ability to detect slight motion. MRE studies have also been tried to assess prostate cancers.

In diffusion weighted imaging (DWI), image contrast arising out of the differences in the motion of water molecules between tissues is utilized for imaging. No external contrast agents are needed. The Apparent Diffusion Constant (ADC) parameter was found to be higher in tumor tissues compared to normal tissues, and hence, this ADC has been used in the assessment of metastatic breast cancer response to chemoembolization. DWI-MRI has also been used for evaluating a variety of other cancers including liver, prostate and pancreatic carcinomas.

Based on an analysis conducted to study the correlation between film mammography and MRI in screening breast cancer in high-risk women. There is no significant correlation, and suggested that using both modalities for screening is likely to improve the odds of detecting early stage cancers. MRI is useful for women with a higher risk of breast cancer, has good image resolution, is effective for evaluating dense breasts, helps to evaluate inverted nipple, allows the simultaneous evaluation of both breasts, helps to determine whether lumpectomy or mastectomy is the best treatment, and it has no side effects as there is no radiation. The limitations of this technique are that it is not good at diagnosing ductal carcinoma in situ (DCIS), may lead to many false positives, is slow (30 min to one hour), more expensive, and may not show all calcifications.

E. POSITRON EMISSION TOMOGRAPHY

Positron emission tomography (PET) is a nuclear medical imaging technique that can be used to produce three dimensional images which is further used for detecting a pair of γ rays, which are emitted from the radionuclide that is introduced into the human body. Malignant tumors are characterized by increased glucose metabolism compared with normal cells which gradually produces a good contrast between cancerous and normal cells in PET images. It provides information about the chemical functions inside organs and tissues. But the limitation of PET is that it is very expensive and yields poor resolution images. Furthermore, the patient is subjected to radiation exposure. PET has been used frequently to predict treatment response in several cancers.

Both imaging modalities i.e., the Single photon emission computed tomography (SPECT) and PET uses radiolabeled isotopes and provide unique opportunities to study animal models of breast cancer with direct application to human imaging.

Both MRI and PET are complementary. They are valuable in monitoring response and assessing residual disease of locally advanced breast cancer treated with neoadjuvant chemotherapy. It is suggested that the combined use of MRI and PET were complementary and offered advantages over clinical breast examination. PET was more accurate in predicting pathologic non-response, and the response evaluated using MRI correlated well with macroscopic pathologic complete response.

Scintimammography (SMM) is useful for assessing palpable breast masses in women with dense breasts. SMM, SPECT and PET can be used as adjunct imaging tools for detecting and staging breast cancer, however, they cannot replace invasive procedures, due to insufficient sensitivity to detect small (less than 1 cm) tumor deposits. Several enzymes and receptors have been targeted for imaging breast cancers with PET. Fluorodeoxyglucose is a useful agent in the detection and staging of recurrent breast cancer and assessing its response to chemotherapy.

Since PET and mammogram are complimentary, PET used to complement mammography is known as positron emission mammography (PEM), and it has been reported that PEM may not be adversely affected by breast density, hormone replacement therapy, and menopausal status of the patient.

F. SCINTIMAMMOGRAPHY

It is difficult to detect breast cancer in dense breast tissue using mammography. As a result, mammogram-based breast cancer detection techniques yield a high number of false positives. The scintimammography imaging technique uses a radioisotope to visualize lesions of the breast. Scintimammography with technetium tetrofosmin (TC-99 tetrofosmin) provides better precision in the diagnosis of women with dense breasts. It is suitable for dense breasts, for the image breasts with implants and for image large and palpable abnormalities, and also be used when multiple tumors are suspected. A high-resolution breast-specific gamma camera was used to evaluate the occult breast cancer in women at high risk of breast cancer. The authors found that high-resolution breast-specific scintimammography was able to detect small (< 1 cm), mammographically occult, nonpalpable lesions not otherwise detected by mammography or physical examination in women with increased risk for breast cancer. The sensitivity and specificity of Breast-Specific Gamma Imaging (BSGI) for the detection of breast cancer by using pathologic results as the reference standard was determined. BSGI showed high sensitivity (96.4%) and moderate specificity (59.5%) in the detection of breast cancers.The joint use of mammography and 99mTc-methoxy isobutyl isonitrile (MIBI) scintimammography reduces the number of biopsies required in patients who

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016

National Conference on Digital Signal Processing, Information and Communication Engineering

Govt. Polytechnic College, Kasaragod

Vol. 5, Special Issue 4, November 2016

are suspected with breast cancer. The total number of biopsies performed was reduced by 34%. In scintimammography with Tc99m compounds, the value of planar Tc99m sestamibi scanning for auxiliary lymph node evaluation was presented. Their work confirmed that non-tomographic Tc99m sestamibi scintimammography had a very low detection rate for auxiliary lymph node involvement and may not be suitable for clinical assessment of breast cancer.

G. OPTICAL IMAGING

Since the background signals can be suppressed using enzyme-activated fluorescence probes,Optical imaging offers complementary features to radiologic imaging techniques, primarily the quantitative imaging of haemoglobin saturation and concentration, and the selective imaging of specific gene expression with high sensitivity.

The different types of optical imaging which use different wavelengths of light to detect breast lesions are optical imaging uses near infrared (NIR) wavelength light to detect lesions inside the breast and diffuse optical imaging (uses NIR light to penetrate into the breast), diffuse optical tomography (uses NIR light of wavelength 700 to 1000 nm), and optical mammography (uses laser light)

Diffuse optical imaging (DOI) is an optical technique which uses NIR light to characterize the properties of thick tissues. The DOI performance involves several factors which are intrinsic and extrinsic contrast mechanisms, quantitation of biochemical components, and image formation/visualization. The major aim in DOI is to develop standardized DOI platforms that can be used as stand-alone devices or in conjunction with MRI, mammography, or ultrasound which can provide new insights for detecting disease in mammographically dense tissue, distinguishing between malignant and benign lesions, and understanding the impact of neoadjuvant chemotherapies.This method can also characterize vascularization, permeability, and a plethora of contrast agents with high sensitivity, without using harmful radiation, and probably at less cost.

H. ELECTRICAL IMPEDANCE BASED IMAGING

The major advantage with the body tissues is that it offers impedance to the flow of electric current. It has been proven that cancerous breast tissues have lower impedance when compared to normal tissues. Zou et al presented a review of the noninvasive impedance imaging techniques for breast cancer detection, such as EIT and EIM. Electrical impedance tomography (EIT) and electrical impedance scanning (EIS) are the two types of electrical impedance based imaging techniques available. In EIT, 2D or 3D images are reconstructed from a large number of impedance values which are captured by placing electrodes around the breast surface in a circular fashion. However, in EIS or electrical impedance mapping (EIM), a planar electrode array is used and there is no need for complicated reconstruction algorithms which are used for EIT.

An invasive impedance technique can be more effective by combining it with other cancer indicators. They have proposed the possibility of improving EIM using a pair of electrode arrays, one for exciting the breast surface and the other for measuring the impedance. They concluded that magnetic induction tomography and other magnetic induction based impedance imaging techniques are promising.

The T-SCANTM technology was discussed by Assenheimer et al. it is said that it can be used as a diagnostic tool for breast cancer detection. To show that the display of planar two-dimensional maps of the currents detected at the breast's surface related to the electric field distribution within the breast, they used theoretical models with simplified geometries. To discriminate between various pathological states, the differences in the distribution of the various tissue types can be used. EIS has been found to provide a rather high sensitivity for the verification of suspicious breast lesions. They also suggested that low frequency impedance measurements can be used in breast cancer diagnosis.

I. CT

Computed tomography uses X-rays to capture 2D images. It can also be used to capture the slices of the examined body parts. Subsequently, different algorithms are used to generate corresponding 3D images which provide anatomical information such as the location of lesions. Usually CT has low contrast, and hence, iodinated contrast media is injected intravenously to increase the contrast of the CT images. The iodine contrast injection dramatically enhances the visualization of tumors. The diagnostic accuracy of CT perfusion in differentiating metastatic from inflammatory enlarged axillary lymph nodes in patients with breast cancer was evaluated.

They showed that CT perfusion may be an effective tool for studying enlarged axillary lymph nodes in patients with breast cancer. The study presents information on vascularization of lymph nodes, helping to understand the changes occurring when neoplastic cells implant in lymph nodes. The lifetime attributable risk (LAR) of cancer incidence associated with radiation exposure from 64-slice computed tomography coronary angiography (CTCA) was studied and the influence of age, sex, and scan protocol on cancer risk was evaluated. These estimates, which were derived from simulation models, suggest that the use of 64-slice CTCA was associated with a non-negligible LAR of cancer. This risk varies markedly and was considerably greater for women, younger patients, and for combined cardiac and aortic scans.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

NCDSPICE 2016

National Conference on Digital Signal Processing, Information and Communication Engineering

Govt. Polytechnic College, Kasaragod

Vol. 5, Special Issue 4, November 2016

Recent study has also introduced a hybrid technique combining PET and CT which is useful for staging potential metastatic cancers. This technique has the combined advantages of both CT and PET. The major differences includes that tumor location is better captured by CT and PET indicates a metabolically active or malignant tumor based on glucose uptake. CT often incidentally identifies lung nodules during exams for other lesions in the thorax. Therefore, recently, a dedicated breast CT prototype that has a high-resolution, isotropic, rotating detector was developed. Subjective evaluation of breast CT images revealed excellent anatomical detail, good depiction of microcalcifications (Microcalcifications are small deposits of calcium salts within breast tissue that appear as small bright spots in mammograms[15]), and exquisite visualization of soft tissue components which belong to the tumor when contrasted against adipose tissues.

III. ALGORITHMS USED FOR CLASSIFICATION

The most used algorithms for breast cancer detection and classification are:

A. SUPPORT VECTOR MACHINE

Support vector machine is a very strong and sophisticated machine learning algorithm especially when it comes to predictive analysis [5]. We have studied and implemented SVM using two kernels: linear and Gaussian. When it comes to classifying separable dataset we prefer linear kernel (as shown in figure 3) whereas for non-linear dataset classification we opt for kernel selection such as Gaussian (as shown in figure 4), polynomial.

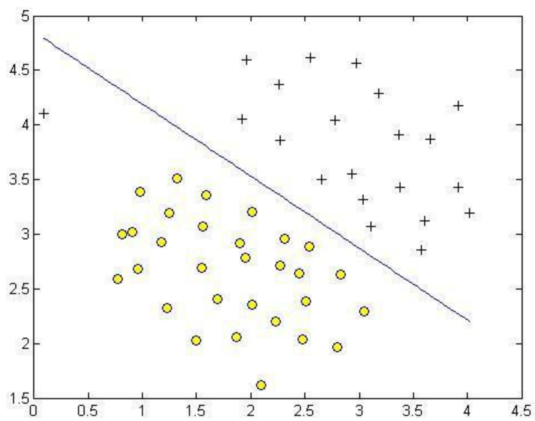

Fig. 3 Linear SVM hyperplane construction [5]

Support Vector Machine is a training algorithm for learning classification and regression rules from data [8]. SVM focuses in determining the hyperplane such that it divides the region into two classes.

$$\text{Hyperplane} = w \times X + b \qquad (1)$$

This equation is dependent on weight vector (w), bias element (b) and the support vectors (X). Vectors that lie closest to the hyperplane are support vectors. Support vectors are responsible for determining the hyperplane.

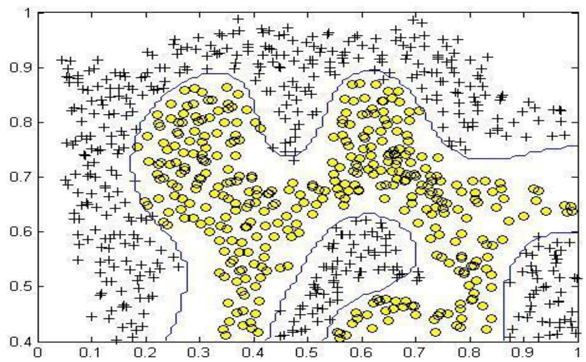

Fig. 4 Gaussian SVM hyperplane construction [5]

B. LOGISTIC REGRESSION

Logistic regression can be binomial or multinomial. Binomial or binary logistic regression can have only two possible outcomes. The outcome is usually coded as "0" or "1", as this leads to the most straightforward interpretation. If possible outcome is success then it is coded as “1” and the contrary outcome referred as a failure is coded as "0". Logistic regression is used to predict the odds of being a case based on the values of the independent variables (predictors). The odds are defined as the probability that a particular outcome is a case divided by the probability that it is a noncase. Logistic regression technique uses sigmoid function to carry out the classification.

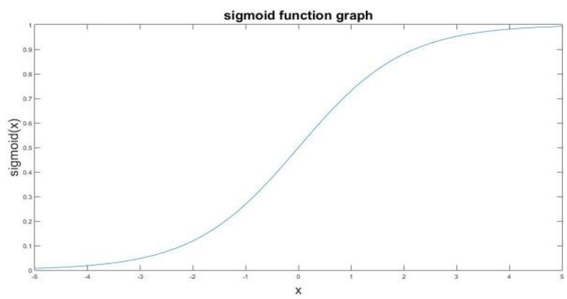

Fig. 5 Sigmoid Function graph

We have also implemented the logistic regression technique using the regularization parameter „lambda‟ that solves the overfitting problem thereby giving us better results than the generalised logistic regression technique.

C. KNN

The k-Nearest Neighbour algorithm is a non-parametric method used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space. The KNN algorithm is among the simplest of all machine learning algorithms.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering
NCDSPICE 2016
National Conference on Digital Signal Processing, Information and Communication Engineering
Govt. Polytechnic College, Kasaragod
Vol. 5, Special Issue 4, November 2016

Both for classification and regression, it can be useful to weight the contributions of the neighbours, so that the nearer neighbours contribute more to the average than the more distant ones. For example, a common weighting scheme consists in giving each neighbour a weight of 1/d, where d is the distance to the neighbour. We have considered Euclidean and Manhattan distance measures to assign weights and determine the neighbours.

If we consider two points x_i and y_i in n dimensional space then:

$$\text{Euclidean}(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2} \quad (2)$$

$$\text{Manhattan}(x,y) = \sum_{i=1}^{n}|x_i - y_i| \quad (3)$$

D. NAIVE BAYES

Naive Bayes classifiers are a family of simple probabilistic classifiers based on applying Bayes' theorem with strong (naive) independence assumptions between the features. Naive Bayes is a simple technique for constructing classifiers: models that assign class labels to problem instances, represented as vectors of feature values, where the class labels are drawn from some finite set. It is not a single algorithm for training such classifiers, but a family of algorithms based on a common principle: all naive Bayes classifiers assume that the value of a particular feature is independent of the value of any other feature, given the class variable . Using Bayes' theorem, the conditional probability can be decomposed as:

$$P(C_K|x) = \frac{P(C_K) \times P(x|C_K)}{P(x)} \quad (4)$$

Here we have implemented the classifier by considering the normal distribution and the kernel distribution.

IV. CONCLUSION

Current breast imaging modalities play a vital role in assisting clinicians in the primary screening of cancer, in the diagnosis and characterization of lesions, staging and restaging, treatment selection and treatment progress monitoring and in determining cancer recurrence. In this paper, I have discussed the capabilities of the different breast imaging techniques that are currently used in clinical setups. It is evident from the material presented in this paper that no single modality is completely useful in all areas of breast cancer management. Therefore, research is continually being carried out to improve the existing modalities and develop new modalities based on the physical, chemical, and biological properties of cancerous breast tissue that differentiates it from normal and benign tissues. A patient with mass detected on mammogram screening has probability of five times higher in getting breast cancer[6]. Cancer is a disease with no specific cure, and its treatment involves a wide variety of side-effects. Moreover, the survival rate is largely dependent on early detection. A disease with such disturbing and life-threatening factors warrants a huge amount of research to develop modalities (screening, diagnostic, adjunct, standalone, and hybrid) that help in early detection and in finding a possible cure. Currently, research on modality development is moving towards imaging at the molecular level.

This type of imaging will also help in understanding the nature of cancer growth and development which in turn might lead us closer to finding a possible cure for this disease. Moreover, the use of computer-aided diagnosis techniques has been widely advocated for the improvement of cancer detection efficiency and for reducing the inter-observer variability that is associated with the subjective human interpretation of the images obtained.

Each algorithm performs in a different way depending on the dataset and the parameter selection. ANNs are useful when there are implicit interactions and complex relationships in the data, whereas logistic regression models are the better choice when one needs to draw statistical inferences from the output[4]. For overall methodology, KNN technique has given the best results. Naive Bayes and logistic regression have also performed well in diagnosis of breast cancer. As said earlier, SVM is a strong technique for predictive analysis and owing to the above finding, it is evident that SVM using Gaussian kernel is the most suited technique for recurrence/non-recurrence prediction of breast cancer.

V. FUTURE SCOPE

The SVM (SMO) that is being described in this paper is only applicable when the number of class variable is binary. In experiments demanding several classes, wecan't have more than 2 classes. To solve this problem scientists have come up with multiclass SVM. Further researcheshave also introduced several classes such as the creation of SVM classes like LIBSVM has taken place. Further fine tuning of several parameters used in algorithms can result in better accuracy. This field has further scope of research.

REFERENCES

[1] Logistic Regression Model for Breast CancerAutomatic Diagnosis, Ahmed F. Seddik, Doaa M. Shawky, SAI Intelligent Systems Conference 2015
[2] Breast cancer diagnosis using machine Learning algorithms –a survey, B.M.Gayathri., C.P.Sumathi and T.Santhanam, International Journal of Distributed and Parallel Systems (IJDPS) Vol.4, No.3, May 2013
[3] Breast imaging: A survey, Subbhuraam Vinitha Sree, Eddie Yin-Kwee Ng, Rajendra U Acharya, and Oliver Faust , World journal of clinical oncology, Published online 2011 Apr.

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940
IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering
NCDSPICE 2016
National Conference on Digital Signal Processing, Information and Communication Engineering
Govt. Polytechnic College, Kasaragod
Vol. 5, Special Issue 4, November 2016

[4] Comparison of Logistic Regression and Artificial Neural Network Models in Breast Cancer Risk Estimation, Turgay Ayer, Jagpreet Chhatwal,, Oguzhan Alagoz, Charles E. Kahn, Ryan W. Woods and Elizabeth S. Burnside, The journal of continuing medical education in radiology, Jan 2010
[5] Breast cancer diagnosis and recurrence prediction using machine learning techniques, Mandeep Rana , Pooja Chandorkar , Alishiba Dsouza , Nikahat Kazi , IJRET: International Journal of Research in Engineering and Technology.
[6] Breast cancer analysis using logistic regression, H. Yusuff, N. Mohamad U.K. Ngah & A.S. Yahaya, IJRRAS, Jan 2012
[7] Latest Advances in Computer-Aided Detection of Breast Cancer by Mammography, R.Bhanumathi, G.R.Suresh, IJITE Vol.01 Issue-06, Nov., 2013.
[8] Breast Cancer Classification using Support Vector Machine and Genetic Programming, K.Menaka , S.Karpagavalli, International Journal of Innovative Research in Computer and Communication Engineering, Vol. 1, Issue 7, September 2013
[9] Segmentation of Breast Regions in Mammogram Based on Density: A Review, Nafiza Saidin, Harsa Amylia Mat Sakim, Umi Kalthum Ngah and Ibrahim Lutfi Shuaib, Imaging & Computational Intelligence Group (ICI) School of Electrical and Electronic Engineering Universiti Sains Malaysia
[10] www.cancer.org/americancancersociety
[11] Assessment of algorithms for mitosis detection in breast cancer histopathology images, Mitko Veta , Paul J. van Diest , Stefan M. Willems , Haibo Wang , Anant Madabhushi , Angel Cruz-Roa , Fabio Gonzalez, e-mail: mitko@isi.uu.nl, Image Sciences Institute, University Medical Center Utrecht, Heidelberglaan 100, 3584 CX Utrecht, The Netherlands
[12] Inferior Breast-Chest Contour Detection in 3-DImages of the Female Torso, lijuan zhao, audrey cheong, gregory p. Reece, michelle c. Fingere,shishir k. Shah (senior member, ieee), and fatima a. Merchant (senior member, ieee)
[13] Classification and Immunohistochemical Scoring ofBreast Tissue Microarray SpotsTelmo Amaral, Stephen J. McKenna, Katherine Robertson, and Alastair Thompson, ieee transactions on biomedical engineering, vol. 60, no. 10, october 2013
[14] High Accuracy Gene Signature for Chemosensitivity Prediction in Breast Cancer, Wei Hu, tsinghua science and technology, Volume 20, Number 5, October 2015
[15] Topological Modeling and Classification of Mammographic Microcalcification Clusters, Zhili Chen, Harry Strange, Arnau Oliver, Erika R. E. Denton, Caroline Boggis, and Reyer Zwiggelaar, ieee transactions on biomedical engineering, vol. 62, no. 4, april 2015
[16] AggNet: Deep Learning From Crowds for Mitosis Detection in Breast Cancer Histology Images, Shadi Albarqouni, Christoph Baur, Felix Achilles, Vasileios Belagiannis, Stefanie Demirci, and Nassir Navab, ieee transactions on medical imaging, vol. 35, no. 5, may 2016
[17] A low-cost screening method for the detection of the carotid artery diseases, Ahmed F. Seddik , Doaa M. Shawky, Journal Knowledge-Based Systems Volume 52, November, 2013
[18] Discover the Expert: Context-Adaptive Expert Selection for Medical Diagnosis, Cem Tekin, Onur Atan, and Mihaela Van Der Schaar, Department of Electrical Engineering, University of California at Los Angeles, Los Angeles, CA 90095 USA
[19] A Radar-Based Breast Cancer Detection System Using CMOS Integrated Circuits, Hang Song, Hayato Kono, special section on bio-compatible devices and bio-electromagnetics for bio-medical applications
[20] Comparative Analysis of Logistic Regression and Artificial Neural Network for Computer-Aided Diagnosis of Breast Masses, Jae H. Song, MS, Santosh S. Venkatesh, Academic Radiology, Vol 12, No 4, April 2005
[21] Computational Pathology to Discriminate Benign from Malignant Intraductal Proliferations of the Breast, Fei Dong, Humayun Irshad, research articleDecember 9, 2014
[22] www.trauma.org
[23] American College of Radiology, ACR BI-RADS—Mammography, Ultrasound & Magnetic Resonance Imaging, 4th ed. Reston, VA: Amer. Coll. Radiol., 2003.