

Identification of Malignant Regions using Infrared Image Processing

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Abstract— The purpose of this research is to see how thermal imaging detects aberrant cells in the human body. The goal of this study is to look at the unsolved challenges of identifying malignant regions. The suggested system uses thermal pictures as an input, for image processing one must follow pre-processing process.. It removes data that isn't relevant to the image processing and boosts certain image qualities that are important for further processing. The region of interest (ROI) is then detected using binarization, edge detection, and picture segmentation.

We are satisfied with the results obtained utilizing thermal infrared cameras to detect the temperature of bodies and physical entities in nature, especially in terms of relevance and higher meaningfulness when compared to other competing approaches. The study employed advanced pattern classification techniques such as SVM and Random Forest, Nave Bayes & Neural Network K-Nearest Neighbour, Adaboost, and Logistic Regression, as well as the Visual Lab Breast Cancer Database using 5 folds, 10 folds, 20 folds with training set size 50, 60, 70, 80, and 90 respectively. Pre-processing, feature extraction, segmentation, and classification of digital mammography and digital infrared thermal pictures are also proposed. These techniques achieved an accuracy of 97.4%, 98.40%, and 99.7% through the random sampling cross-validation of Support Vector Machine, Random Forest method, and Logistic Regression respectively. Such kind of performance analysis on the thermal image of breast cancer is not found in reputed journals.

Index Terms— Malignancy, SVM, KNN, Random forest, Logistic Regression, Adaboost Thermal Imaging, Breast cancer

I. INTRODUCTION

Thermograph, as a simple, noncontact, non-invasive and inexpensive imaging method, is widely applicable in a variety of different fields in industry and research. Most applications of thermal imaging perform the Investigation in a *passive* manner, which means that the camera observes a scene and detects the thermal radiation emit- ted by objects. Many applications of thermal imaging are based on taking a single image and analysing the recorded temperature distribution. This method of analysis is called static thermal imaging.

However, some processes show temperature change rates which cannot be approximated as static. For this purpose, dynamic thermal imaging (DTI) is applied. DTI monitors, or quantitatively measures, temporal changes in temperature over areas of interest. These thermal changes can be monotonic (areas of interest are only warming or cooling), or periodic (manifested as temperature modulation).

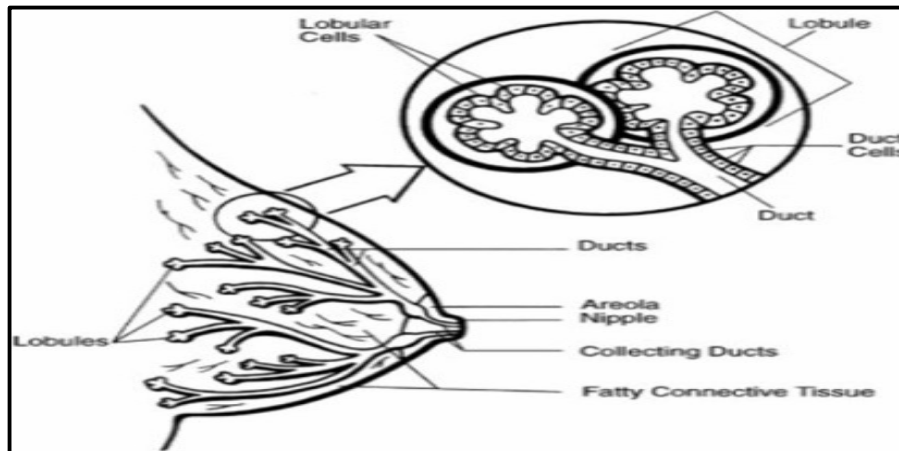


Fig 1 Structure of Brest cancer

In this research work, proposed the unexplored problem of identification of malignant regions using Thermal Infrared Image. The research work introduced a topology driven capturing images and a process that relies on five basic steps to identify. The research work has been positively impressed by results achieved on thermal infrared cameras for measuring the temperature of body and physical entities of nature, especially in terms of significance and higher meaningfulness with respect to other competing methods. Future directions of research have also been issued.

Breast cancer is the most common cause of cancer in women and the second most common cause of cancer death in women in the United States. Breast cancer refers to cancers originating in the breast tissue, most commonly of the internal mucous membrane of the ducts with milk. In 2004, breast cancer caused 519,000 deaths worldwide.

II. METHODOLOGY

In recent years there has been a resurgence of interest in the application of infrared thermal imaging in medicine. Fairly little effort has been spent towards standardization of the field and a common communication and exchange format for thermal images. In this work researchers investigate how the DICOM standard in its current form can be adopted to store and communicate medical infrared images [2]. Infrared thermal imaging of the skin has been used for several decades to monitor the temperature distribution of human skin. Abnormalities such as malignancies, inflammation, and infection cause localized increases in temperature which show as hot spots or as asymmetrical patterns in an infrared thermogram. The ability to measure power consumption is at the heart of power and thermal management techniques. Modern processors are equipped with hardware monitoring mechanisms that can measure total power. Thermography, with high-resolution cameras, is being re-investigated as a possible breast cancer screening imaging modality, as it does not have the harmful radiation effects of mammography. This research work focuses on automatic extraction of medically interpretable non-vascular thermal features. Researchers design these features to differentiate malignant from different non-malignant conditions, including hormone sensitive tissues and certain benign conditions, which have an increased thermal response. These features increase the specificity for breast cancer screening, which had been a long known problem in thermo graphic screening, while retaining high sensitivity. On a dataset of around 78 subjects with cancer and 187 subjects without cancer, that have some benign diseases and conditions with thermal responses, researchers are able to get around 99% specificity while having 100% sensitivity. This indicates a potential break-through in thermography screening for breast cancer. This shows promise for undertaking a comparison to mammography with larger numbers of subjects with more data variations [8]. Breast cancer ranks second among cancer related deaths in women in the USA. 84 Media-Lateral Oblique (MLO) mammograms were processed using the proposed method [results are available on request], and a few results are reported. For 84 mammograms, False Positive (FP) and False Negative (FN) values were calculated and its analysis is reported in Table 1 along with the values obtained for the state-of-the-art methods. The treatment of early development of

breast tumor has a higher success rate. This research work presents a framework for the early discovery of breast cancer. The proposed detection process consists of a preliminary screening process and a prediction process. The prediction process using artificial intelligence techniques aims to use past records of other similar cases to enhance the forecast of breast cancer development. The research work discusses the issues and techniques for the implementation of the proposed framework. These include the preliminary screening process, the retrieval of the relevant cases, and the prediction of the risk of developing breast cancer based on the thermo grams, environmental/social data, physiological information, genetic factors, and medical records. Conclusions and potential areas of research are highlighted [40].

Darko Kolari et. al. (2011) studied an application of infrared thermal imaging in blade based data centers. For this purpose thermal monitoring of computer clusters at the blade-level is conducted using infrared thermal imaging monitoring systems at the blade enclosure level.

Gerald Schaefer et. al. (2006) has explored how the DICOM (Digital Imaging and Communication in Medicine) standard in its current form can be adopted to store and communicate medical infrared images. Darko Kolari et. al. (2011) worked for temperature monitoring analysis, they just do the case study monitoring using thermal imaging was conducted on real blade systems for high performance computing, have shown interesting possibilities of thermal imaging for thermal management of blade systems. Bryan F Jones' and E Francis Ring (1997) studied thermal imaging in medicine.

N.A. Ivanescu et. al (2010) have explored the work procedure that implies the acquisition, processing and analysis of video images in order to obtain the 3-D characteristics and then integration of temperature data from the thermal camera. With the help of a frame grabber, a 25 fps feed from the video camera is achieved. In these images, precisely because of the angular difference between the two elements, the laser beam from the line generator is observed as being a curve line when it passed on the patient's body

Jean Gauci et. al. (2017) shows the number of algorithms to automatically extract temperature data from thermal images of the volar aspect of human hands from eight pre-specified ROIs. Junghoon Lee et. al. (2008) applies algorithms to famous diseases, such as a foot of the glycosuria, the degenerative arthritis and the varicose vein.

Pramit Brata Chanda and Subir Kumar Sarkar (2018) have aimed to illustrate the Detection and classification of different types of breast cancer from mammogram images using the Support Vector Machine classifier. The Segmentation and classification approach is performed on MIAS Breast cancer images. Experimental results show that more than 80% Linear and Quadratic classification accuracy.

E. Karthikeyan, S. Venkatakrishnan (2019) describes the CAD system for detecting breast cancer in the ROI of digital mammography. The study also examined system performance using the GLRLM and SVM methods. These results indicate that the GLRM and SVM transformations are useful methods and are widely used to distinguish mammographic images as normal, benign and malignant.

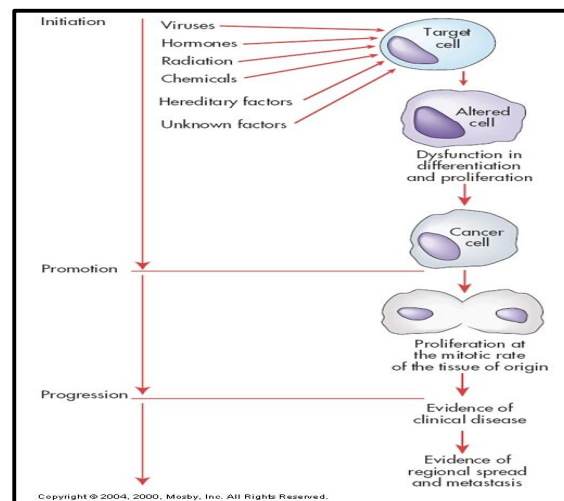


Fig.2 Process of Cancer Development

Y. Ireaneus Anna Rejani et. al. (2009) have worked and summarized the developed method, the initial step, based on gray level information of image enhancement and segments of the breast tumor. For each tumor region extract, morphological features are extracted to categorize the breast tumor. Finally the SVM classifier is used for classification.

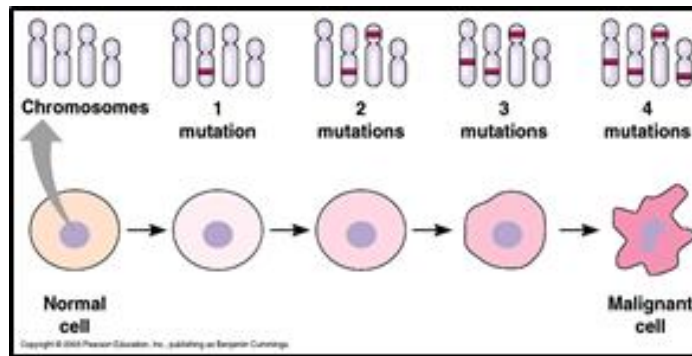


Fig 3 Selection within tumor for “most cancerous” cells

K. Vaidehia and T. S. SubashinibIn (2014) have proposed an automatic system which detects and categorizes benign mass and malignant mass regions from the breast ROI. Mini-mias database images are used for this study. This automatic detection of masses is beneficial to the radiologist for finding the early stage of (benign) mass and cancerous stage (malignant) without confusion. Even though the mass regions are obscured in the dense regions, the study reveals the usefulness of fuzzy C-means algorithm for segmenting mass regions from the ROI. The experimental results show that the extracted GLCM descriptors along with SRC classifier could be effectively used in classifying breast masses in digital mammograms. The SRC classifier obtained highest accuracy is 93.75%. The proposed work was carried out using MATLAB 2012a.

III. EXPERIMENTAL WORK

A. System Development

As the proposed system includes thermal images as an input, it is necessary to follow pre-processing steps of image processing. It suppresses information that is not related to the specific image processing and enhances some image features important for further processing. Then binarization, edge detection, image segmentation to detect region of interest (ROI) is performed.

There are different Imaging Techniques as given below:

- X- ray imaging
- Magnetic resonance imaging (MRI)
- Elastography
- Tom synthesis
- Computer tomography (CT)
- Positron emission tomography (PET)
- Photo acoustic imaging
- Optical imaging
- Thermal imaging

1. Thermo graphic Imaging System

This section presents the conceptual architecture of the developed system and the methods used for its development. The system architecture is composed of hardware and software components, encompassed by the system workflow. As main components of the system’s functionality, calibration process and motion capturing and analysis are described.

Thermal imaging has become much more popular over the past 10 years because uncooled micro bolometer technology has lowered prices significantly on the infrared (IR) equipment. Knowing the potential uses and importantly, the limitations of thermal imaging will help to decide whether it might be wise to perform thermal imaging of Facilities and/or electro-mechanical equipment for purposes of commissioning, diagnostic and/or condition-based maintenance activities.

Thermography is a test that uses an Infrared camera to detect heat patterns and blood flow in body tissue. DITI is the type of thermography that's used to diagnose breast cancer. These thermo grams are pseudo colour thermo grams in which red and white intensities correspond to the high temperature region and hence indicate the presence of the abnormality.

Normal Mole	Melanoma	Sign	Characteristic
		Asymmetry	when half of the mole does not match the other half
		Border	when the border (edges) of the mole are ragged or irregular
		Color	when the color of the mole varies throughout
		Diameter	if the mole's diameter is larger than a pencil's eraser

Photographs Used By Permission: National Cancer Institute

Fig 4 Sign and Characteristics in common cancers

B. System workflow

The concept of the system workflow is based on the conceptual model presented in the research work. The workflow was expanded and modified to allow for the integration of several imaging and acquisition modalities and enhanced data processing for the purpose of health status monitoring.

C. System components

The system consists of two main components: hardware, incorporating four different imaging modalities, and software which enables the calibration and functionality of the whole system. Implemented im-aging modalities include: a thermal measurement camera, a thermal imaging camera, a RGB camera. through these components The structure of the system is presented schematically.

D. Methodology & Tools

Here the research work proposes identification of malignant regions of the body through capturing the image from thermal cameras and processing in MATLAB for identification of malignant regions.

There are different types of images used to analyze the cancer, such as Chest Radiography (X-ray), Computed Tomography (CT), Magnetic Resonance imaging (MRI).The computerized cancer diagnosis comprises of three primary computational steps:

1. Pre-processing

Image pre-processing is a tool which uses lots of pre-processing methods like filtering, normalization, noise removal etc. It suppresses information that is not related to the specific image processing and enhances some image features important for further processing. The Initial level of image pre-processing is image cropping, that means unrelated parts of the image can be detached by in view of the image region of interest (ROI).

2. Feature Extraction

The term feature can be stated as an “interesting” part of an image. Following image pre processing, the elements are extracted either at the tissue or cellular level. Quantification and allocation of the cells from corner to corner the tissue are based on tissue level feature extraction. The properties of individual cells can be extracted based on cellular level feature extraction. There are many features extraction techniques. In this research Scale Invariant Feature Transform (SIFT) is used. [5]

Binarization it is the process of converting a pixel image to a binary image. A binary image is one that consists of pixels that can have one of exactly two colors, usually black and white. In the old days binarization was important for sending faxes. These days it's still important for things like digitizing text or segmentation. Binarize creates a two-level (binary) version of an image whose pixel values correspond to 0s and 1s. Binarize is particularly effective when all foreground pixels have higher intensity values than background pixels. It is a pixel (or point) operation, meaning it is applied to each pixel independently.

There are difference algorithmic techniques researchers have worked for cancer cell classification, such as:

- SVM Learner
- Random Forest Learner

- Neural Network
- Naive bayes
- logistic Regression
- KNN
- AdaBoost

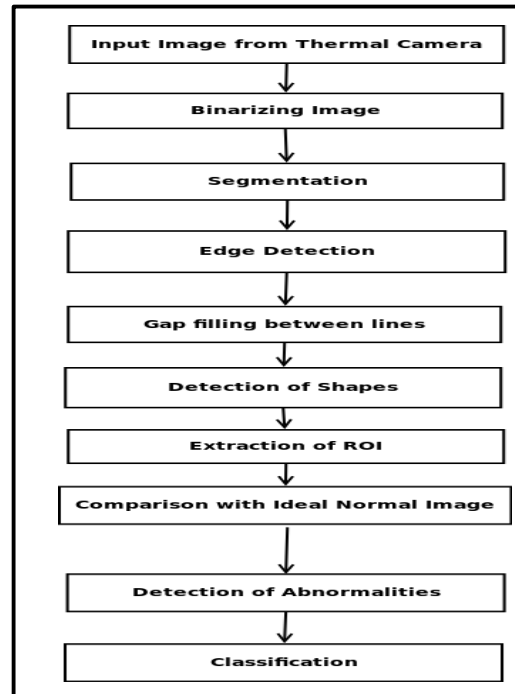


Fig 5 Flowchart

The SVM is a modern technique rapidly gaining popularity as a result of the helpful results that have been accomplished in a widespread diversity of data mining issues, due to their strong hypothetical, theoretical underpinnings in statistical learning theory [11], [12] and [13].

- Support vector machine algorithm is to find a hyperplane in an N-dimensional space (N — the number of features) that distinctly classifies the data points
- SVMs are to find a separating line (or hyperplane) between data of two classes. SVM is an algorithm that takes the data as an input and outputs a line that separates those classes if possible.
- According to the SVM algorithm we find the points closest to the line from both the classes. These points are called support vectors. Now, we compute the distance between the line and the support vectors. This distance is called the margin. Our goal is to maximize the margin. The hyperplane for which the margin is maximum is the optimal hyperplane

Step1: To maximize the margin between the data points and the hyper plane

Step2: Use Hinge loss function that helps maximize the margin

Step 3: Minimize Weight by using equation no 2. Loss function for SVM

3. Proposed Hybrid Approach

The introduced technique is a hybrid method for breast cancer dataset prediction using Two-Step clustering and SVM methods and consists of two sub-methods: Two-Step data clustering based on features similarity using likelihood distance measure, and classification breast cancer dataset based on the SVM algorithm. The purpose of this research is to introduce a cancer diagnostic classification approach with the aid of a hybrid Two-Step data clustering algorithm and the SVM prediction method for the enhancement of the classification accuracy (effectiveness) and to reduce the rate of misclassification. This work pioneers a new approach which combines the supervised and the unsupervised learning methods Two-Step clustering algorithm and SVM techniques. A qualified research has been conducted on the SVM classification and Two-Step data clustering structure on breast cancer features. Then the results of clusters used as inputs to the prediction method using the SVM technique as classifiers for cancer cases. The Hybrid TwoStep-SVM technique is considered to investigate the

result of the trained method. As a result of a large number of cases correlated with the cancer data, The dataset was split into ten parts as 10-folds cross-validations for training and testing the TwoStep-SVM method. Figure 2 shows the stages of the introduced technique (TwoStep-SVM stages).

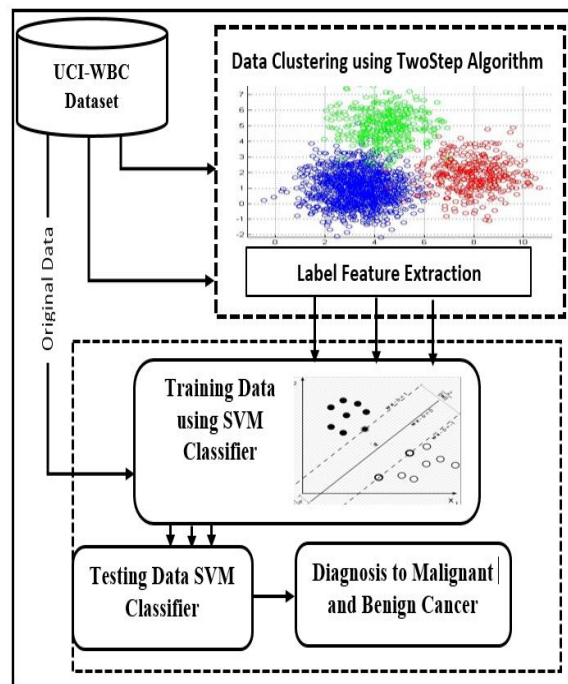


Fig 6 Hybrid Two-Step SVM Stages for proposed approach

IV. EXPERIMENTAL RESULTS

This gives a detailed discussion about experimental results on various datasets used for the research work with different algorithms. As discussed before in about the methodology and experimental setup this research work performs experiments on Virtual Lab Cancer Database.

The following table shows the experimental results for different approaches with different parameters.

A. Experimental Results with Thermal Images

1. With Cross Validation Using 5 Fold with Training set size 50,60,70,80 & 90

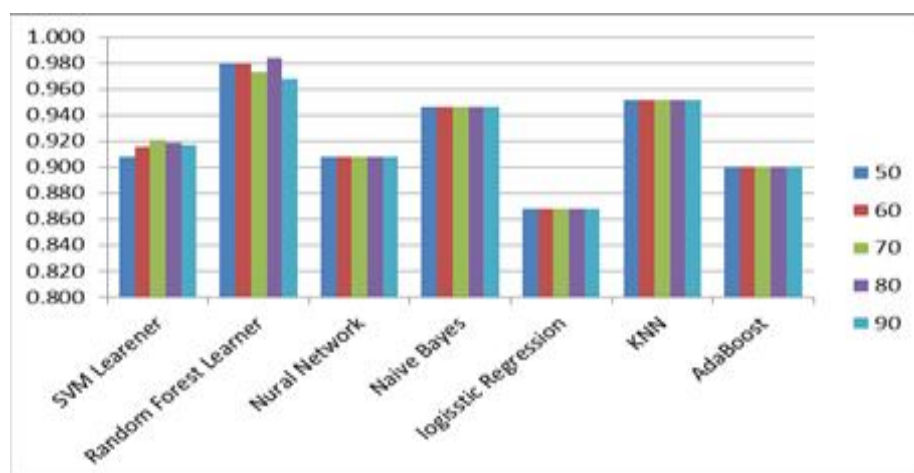


Fig 7 Graph of Cross Validation 10 fold with training set size 50,60,70,80 & 90.

2. With Cross Validation Using 10 Fold with Training set size 50,60,70,80 & 90

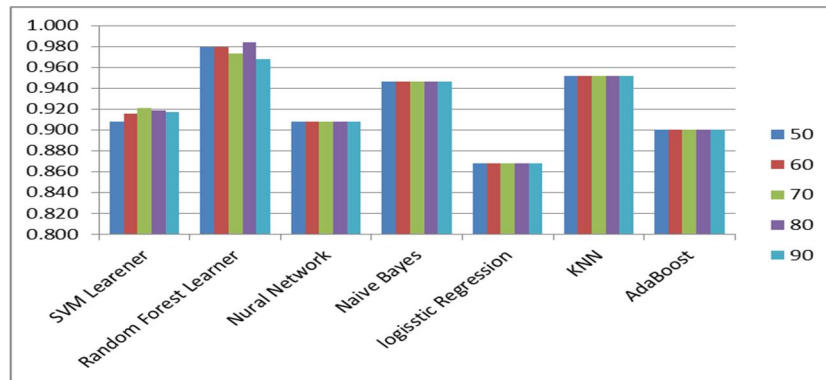


Fig 8 Graph of Cross Validation 10 fold with training set size 50,60,70,80 & 90.

B. Experimental Results with Automatic cropped Thermal Images

1. With Cross Validation Using 5 Fold with Training set size 50,60,70,80 & 90

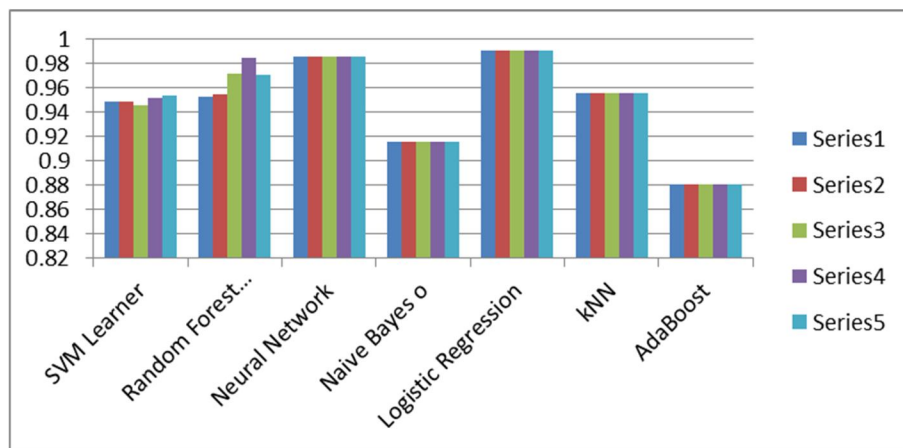


Fig 9 Graph of Cross Validation 5 fold with training set size 50,60,70,80 & 90

2. With Cross Validation Using 10 Fold with Training set size 50,60,70,80 & 90

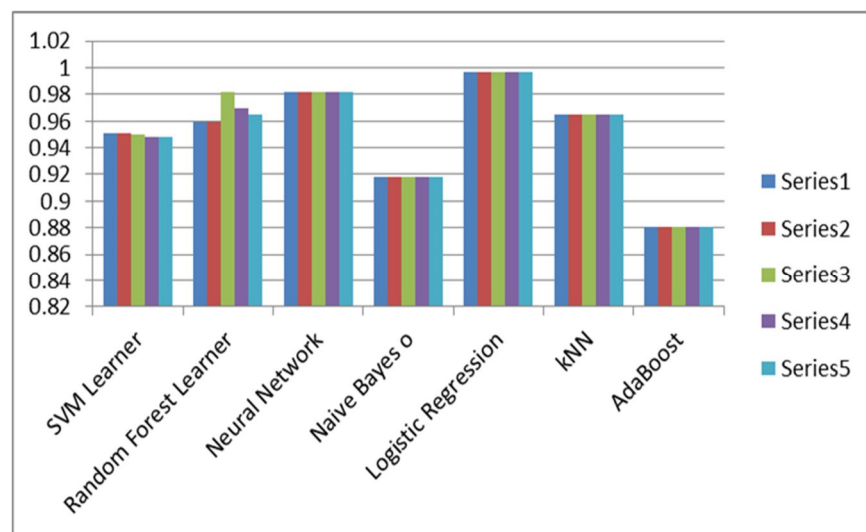


Fig 10 Graph of Cross Validation 10 fold with training set size 50,60,70,80 & 90.

3. With Cross Validation Using 20 Fold with Training set size 50,60,70,80 & 90

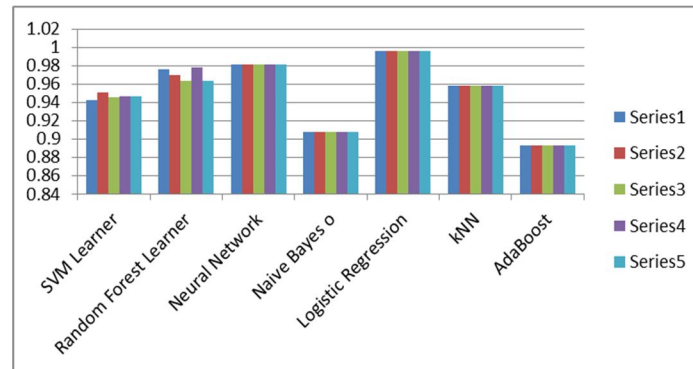


Fig 11 Graph of Cross Validation 20 fold with training set size 50,60,70,80 & 90.

V. RESULT ANALYSIS

The proposed model's performance is compared to that of other models. Existing models were also examined in a literature review and determined to produce good results in the proposed strategy. The SVM and Random Forest, Naïve Bayes & Neural Network K-Nearest Neighbour, Adaboost, Logistic Regression these techniques used to check the performance of the proposed research work. The mammogram images have a 97.4 percent accuracy rate, whereas proposed thermal images have given accuracy rate of 98.4 percent with Random Forest Technique. Automatic cropped images of random sampling and cross validation with training set size 90 which given 99.70 percent of accuracy with Logistic Regression Method.

VI. CONCLUSION

In this research work, proposed the unexplored problem of identification of malignant regions using Thermal Infrared Image. The research work introduced a topology driven capturing images and a process that relies on five basic steps to identify. The research work has been positively impressed by results achieved on thermal infrared cameras for measuring the temperature of body and physical entities of nature, especially in terms of significance and higher meaningfulness with respect to other competing methods. The research work has used Visual Lab Database of Breast cancer and used various advanced pattern classification approaches such as SVM and Random Forest, Naïve Bayes & Neural Network K-Nearest Neighbour, Adaboost, Logistic Regression. Also, an approach is proposed for pre-processing, feature extraction, segmentation and classification of digital mammogram image and digital infrared thermal image. Performance of the proposed model is compared with Existing models studied in the literature survey and found that good results are shown in proposed method. As per the literature survey 97.4% Accuracy using X-ray images and 94.5% using thermal images are found. From the proposed models the experiments have achieved the 98.4% Accuracy. We have been positively impressed by results achieved on thermal infrared cameras for measuring the temperature of body and physical entities of nature, especially in terms of significance and higher meaningfulness with respect to other competing methods.

FUTURE SCOPE

Notably the used based approach performed better than others with mean, variance and standard deviation were added to input in addition to side information. In future, we will develop a low cost thermal image camera for identification of malignant regions and can be used for early detection of cancer.

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