iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VI **Month of publication:** June 2020

DOI: http://doi.org/10.22214/ijraset.2020.6207

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VI June 2020- Available at www.ijraset.com

Tumor localization using Fuzzy and SVM Classifiers

Jenila R
Assistant Professor, Electronics and Communication Engineering, VelTech Rangarajan Dr.Sagunthala R & D Institute of Science and Technology, Avadi, Chennai – 600062

Abstract: Breast cancer comes from uncontrolled growth of diseased breast cells. Prior breast cancer detection can increase the possibilities of a patient's healthy survival. Using thermography, it can be easily detect breast abnormalities from thermal images. The statistical features extracted from the thermogram images is given as the inputs to the Fuzzy classifier and SVM classifier which classifies each input objects to one of the predefined classes. The fuzzy classifier system develops rule-based systems ie, fuzzy If-Then rules. The aid of fuzzy rule based classification is their comprehensibility and high classification ability. In this work, 13 extracted features of various thermal images were given as input of Fuzzy and SVM classifier and the performance of both classifiers were analyzed.
Keywords: Classification, Tumor localization, SVM classifier, Fuzzy If-Then rules

I. INTRODUCTION

Breast cancer occurs when evolution takes place in genes that tune cell growth. The cells (metastasize) keep increasing and eventually form a tumor. Tumor is cancerous (or malignant) when these anomalous cells spread all other parts of the breast. It frequently invades other healthy breast tissue and can move to the lymph nodes, which helps the cancer cells move to other parts of the body. On average, every 2 minutes a woman is diagnosed with carcinoma and 1 woman will die of carcinoma every 13 minutes. Fig. 1 shows the anatomy of the breast. Researchers have established hormonals and behavioral factors which makes the risk of carcinoma. Considerable support for awareness and research funding for carcinoma helps in the detection and treatment of breast cancer. Now the survival rates gets improving and therefore, the number of deaths are steadily declining. However, still improvement of early detection and advanced treatment is necessary in this area.

Mammography, Ultrasound and Magnetic Resource Imaging (MRI) are the various tools for detecting breast cancer. The limitations of these techniques are exposure to radiation, more invasiveand produce false positive results. Thermography is a complementary method for early detection of breast abnormalities. Infrared cameras can detect radiations in the electromagnetic spectrum's infrared range (approximately 0.9 to 14μm) and produce thermogram images. Thermographs measure the infrared heat emitted by human body and translates into thermal images.

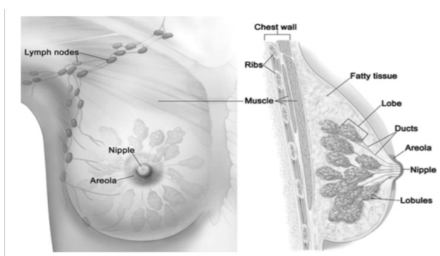


Fig. 1 Breast Anatomy

Any matter, that has higher than zero Kelvin emits electromagnetic infrared radiation (and so humans). The relation between the infrared energy and temperature states by Stefan-Boltzmann law. The measurements of infrared radiation radiated by skin can directly converted to temperature, as the emissivity of human skin is high. Breast thermography is an non-invasive procedure that doesn't require compression or radiation exposure, and functions through physiological function assessment, high resolution breast tissue temperature measurements.

The remaining part of this paper sectioned as follows. Section II briefs some related research. Section III explains the methodology. Section IV gives the conclusion and future work.

II. RELATED RESEARCH

Lessa and Marengoni proposed an Artificial Neural Network classification method to detect breast cancer earlier [2]. The unwanted regions are pre-processed and a mask is created to segment the region of interest (ROI) by applying the canny edge detector in the original image. The various statistical measurements from the breast images related the temperature values of healthy and unhealthy breast. For ANN training, 25 normal and 25 malignant images have chosen randomly. Compared to linear, the non-linear model which achieves 87%, 83% and 85% of sensitivity, specificity and accuracy. Thus, non-linear model has more advantages than linear method.

Lashkari and Firouzmand compares supervised and unsupervised technique that uses infrared images for early detection of breast cancer [4]. First, the segmentation and ROI determination takes place. The features were extracted from the images and the feature selection methods were used to select the best features. The selected features are estimated by unsupervised method (fuzzy C-means clustering) and compared with AdaBoost supervised classifier. The experimental output demonstrates the fuzzy C-means clustering can be preferable as unsupervised technique with a mean accuracy of 75% compared to AdaBoost as the supervised technique with a mean accuracy of 88%.

Wahab *et.al.*, uses Artificial Neural Network for tumor detection in breast thermography [6]. This work makes use of various features extracted from a sequence of simulations performed on various tissue composition breast models. The extracted features fed into the 6-8-1 network architecture, configured ANN framework. It was evolved for testing data with performance accuracy of 96.33% and validation data of 92.89%, respectively. The result obtained shows that ANN is very useful for diagnose on the medical thermal images. Higher quality reconstructed image as it is an extended technique.

Gaber *et.al.*, uses Neutrosophic sets (NS) and fuzzy C-means (FCM) algorithm to determine the benign and malignant breast cancer thermograms. Initially, thermogram images are pre-processed using one of the filter (median filter) and then the images are transformed to neutrosophic domain to decrease the indeterminacy degree of the image using entropy of the indeterminate subset. The various feature extraction techniques are applied to the segmented image and 30 features are extracted. The SVM classifier was used to classify the extracted features. To evaluate the performance, 63 cases (29 normal & 34 affected) are used for testing and training. This system achieves better accuracy 100% based on F-FCM algorithm by applying the neutrosophic sets to the segmentation process.

Gerald Schaefer proposed a classification system based on Ant Colony Optimization (ACO) of thermogram breast cancer analysis [7]. First, the segmention of the breast takes place (the left and right areas). In total 38 features are extracted from the segmented image. ACO is used for the classification of breast thermograms. For experiments, 146 thermograms of a dataset (29 affected and 117 normal cases) are utilized and calculate a feature vector of length 38 for all thermal images. The experimental result shows that ACO classification provides good diagnostic performance with the accuracy of 79.52% based on the compact rule base system.

Dinsha and Manikandaprabu uses SVM and Bayesian classification for breast tumor detection from thermogram images [8]. In this pre-processing involves the conversion of color images to grayscale, denoising, enhancement using CLAHE, segmentation using k means and fuzzy C-means, feature extraction and classification. SVM and Bayesian classifiers are used to classify the features that are extracted. The Matlab software is used for findings and also the 9 datasets of inputs of breast thermogram images are used. The SVM classifier and Bayesian classifier demonstrates the classification performance with the accuracy of 85.71% and 92.86% respectively.

Zadeh *et.al.*, proposed a combination of genetic algorithm and Artificial Neural Network for the carcinoma detection [9]. Initially, the collected infrared images from affected persons under analyze to extract useful information to diagnose carcinoma. To optimize the extracted features, ANN and genetic algorithm are used together. In this, a 3-layer feed-forward neural network with a sigmoidal activation function in the middle layer and linear function in the input layer is considered. To determine the performance of the proposed method, 50 sample images from the database are selected and used for training the neural network. The simulation results indicate that the combinatorial model best classifies the thermograms with 50% sensitivity, 75% specificity and 70% accuracy.

III. PROPOSED METHODOLOGY

This section elaborates the proposed method. Fig. 2 shows the block diagram of the proposed system methodology. This includes preprocessing, segmentation, features extraction and classification.

A. Original Image

Here, consider the infrared image. It is the amount of infrared energy emitted by the human body, particularly in the breast regions. The temperature variations of the breast surface are captured using the infrared cameras as a thermal image.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VI June 2020- Available at www.ijraset.com

The images thus obtained in closed dark chamber to remove interference from outer Infrared (IR) sources.

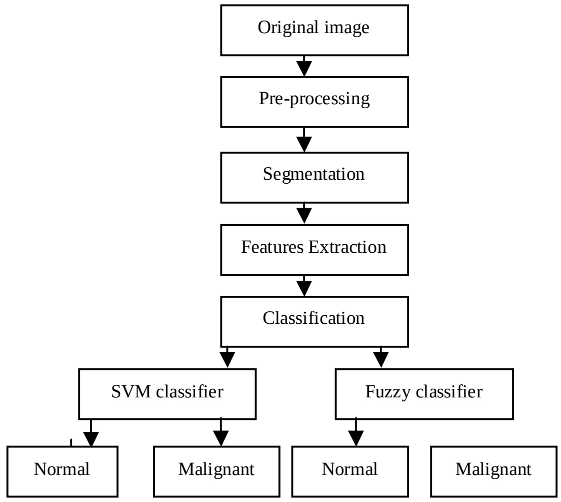


Fig. 2 Block diagram of the proposed method

B. *Pre-processing*

Image pre-processing is a method that improves the visual semblance of the images for next step processing. It refers to key processing step such as: filtering, color transforms, sub-scaling/ sampling and generation. The aim of pre-processing is an enhancement of the image data that vanquishes unwilling distortions or enhances some image features important for further processing.

C. *Segmentation*

Image segmentation is the defined as the digital image divided into multiple segments (edges, boundaries, texture). The segmented image covers the entire image. It includes Compression-based techniques, Histogram-based methods, edge detection and graph partitioning methods.

D. *Features Extraction*

It is the process of obtaining the set of features or image characteristics that represents the information needed for analysis and classification. It is the special form of dimensionality reduction. If the data is too large to be processed, the data will change into a reduced set of features for representation.

The features which describes temperature distributions in thermograms such as

Mean

$$\mu = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N} p(i,j)$$

Variance

$$\sigma^2 = \sum_{i,j}\frac{(xi,j-\mu)^2}{N}$$

Standard deviation

$$S = \sqrt{\sigma^2} = \sigma$$

Smoothness

$$R = 1 - \frac{1}{1+\sigma^2}$$

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VI June 2020- Available at www.ijraset.com

Several features can be obtained from the gray level co-occurrence matrix (GLCM)

Contrast

$$C - \sum_{x} (x-y)^2 I(x,y)$$

Correlation

$$Correlation = \sum_{i,j} \frac{(i = \mu_i)(j = \mu_j)p(i,j)}{\sigma_i \sigma_j}$$

Energy

$$E = \sum_{x} \sum_{y} I(x,y)^2$$

Homogeneity

$$H = -\sum_{x} \sum_{y} \frac{p(x,y)}{1+(x-y)^2}$$

E. Fuzzy Classification System

Fuzzy logic systems label the precision of the input and output variables by indicating fuzzy numbers and fuzzy sets that may be revealed in linguistic variables (eg: small, medium, large). Fuzzy classification is the process in which individuals with the matching attributes has grouped into a fuzzy set. A fuzzy classification corresponds to a membership function µ that indicates whether an individual may be a member of a class.

F. Fuzzy Membership Function

Membership functions can be defined as a technique that uses experience instead of knowledge to solve practical problems. Fig. 3 represents features of membership functions. They characterize all the information present in fuzzy set. Normally, Membership functions represent by means of graphical forms.

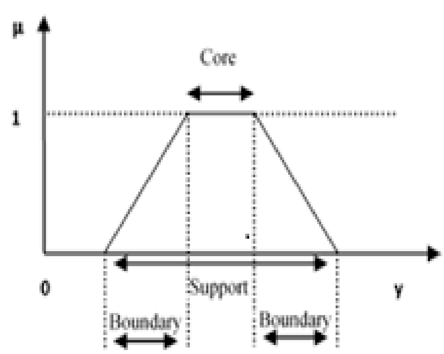


Fig. 3 Features of membership functions

G. Fuzzy If-Then rules

Fuzzy If-Then rules are generated with linguistic interpretation which expresses the relationship between inputs and outputs. A fuzzy If-Then rule assumes in the following form

If x_1 is 'A_1' AND x_2 is 'A_2' then y_1 is 'B_1'

where A_1, A_2 and B_1 are linguistic values defined by fuzzy sets on the ranges x_1, x_2 and y_1 respectively.

The If part of the rule " x_1 is 'A_1' AND x_2 is 'A_2' " (input variables) is the antecedent part, while the then part of the rule " y_1 is 'B_1' " (output variable) is the consequent part.

There are three fuzzy operators AND, OR and NOT. AND indicates the intersection (minimum of the two sets). OR indicates the union (maximum of the two sets). NOT indicates the opposite of the set. Decisions are based on all the rules within the rule base and so the fuzzy output obtained from each rule must be combined to compute the final fuzzy set output(composition or aggregation).

H. Support Vector Machine (SVM)

SVM is based on the concept of decision plane that defines decision boundary. A decision plane is one that separates a set of objects having different class memberships. SVM creates a hyperplane or set of hyperplanes in a high dimensional space which can be used for classification and regression. A classification problem represents the output variable as a category (‘disease’ or ‘no disease’). A regression problem represents the output variable as a real value (‘dollars’ or ‘weight’).

SVM algorithm makes use of mathematical functions that defined as kernel. The kernel function takes collection of data as input and converts it into the specified requirement. Kernel functions of various forms include linear kernel, non-linear kernel, polynomial kernel, RBF kernel and sigmoid kernel.

IV. RESULTS AND DISCUSSIONS

To perform the evaluation, 10 cases (5 normal and 5 abnormal) were analyzed and found that there is a temperature variation between the normal and abnormal images.

The statistical features (13 features) were extracted from the normal and abnormal breast images using MATLAB.

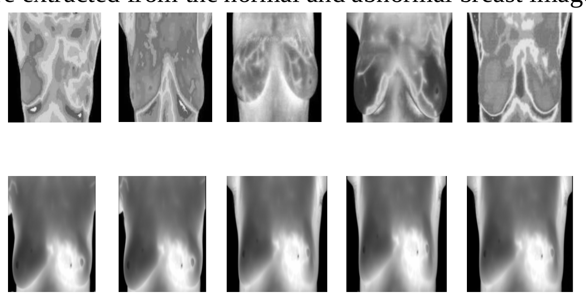


Fig. 3 normal and abnormal breast thermogram image

The extracted features from the normal and abnormal thermogram breast image are tabulated as shown in table.1

Features	Normal1	Normal2	Abnormal1	Abnormal2
Contrast	0.1575	0.1685	0.1203	0.1318
Correlation	0.1569	0.1288	0.1297	0.1435
Energy	0.8545	0.8086	0.8564	0.8545
Homogeneity	0.9533	0.9491	0.9618	0.9613
Mean	0.0017	0.0016	0.0017	0.0025
Std_deviation	0.0801	0.0801	0.0668	0.0668
Entropy	3.4226	3.4534	2.9818	2.9154
RMS	0.0801	0.0801	0.0668	0.0668
Variance	0.0064	0.0064	0.0044	0.0044
Smoothness	0.8832	0.8766	0.9286	0.8869
Kurtosis	7.5152	6.8720	9.9162	14.1548
Skewness	0.4637	0.5363	0.6249	0.9341
IDM	0.0344	-1.1027	-0.2800	0.2906

Table. 1 Statistical features of normal and abnormal image

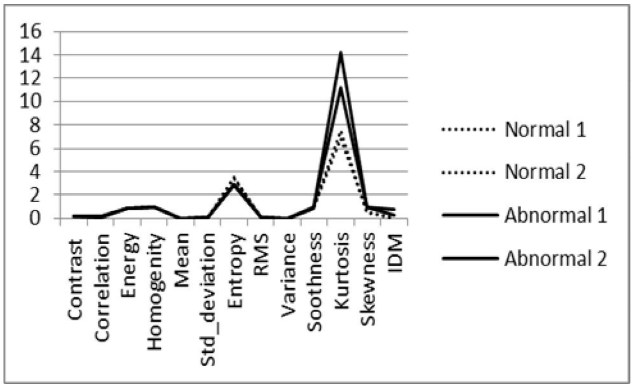


Fig. 4 Normal Vs Abnormal feature comparison

A. Output of Fuzzy classifier

From the 13 statistical features, only 3 features (Contrast, Smoothness, Kurtosis) were fed as input to this classifier system. MF Editor displays the types of MFs of the input and output fuzzy variables.

Fuzzy If-Then rules are defined in the rule editor window. Rules define the behavior of the system. The Rule Viewer enables to understand how each rule contribute towards the output.

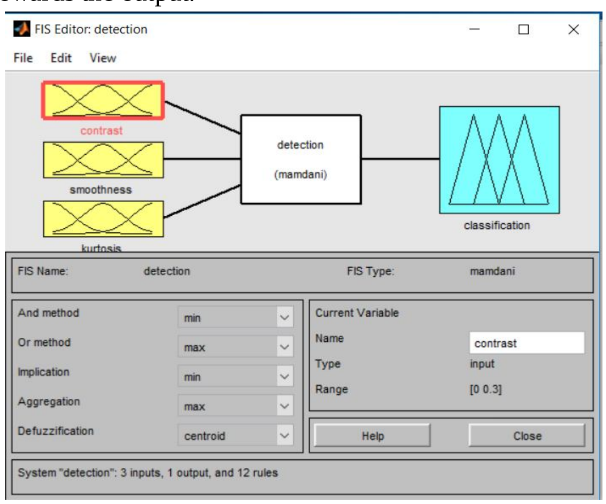


Fig. 5(a) FIS Editor window

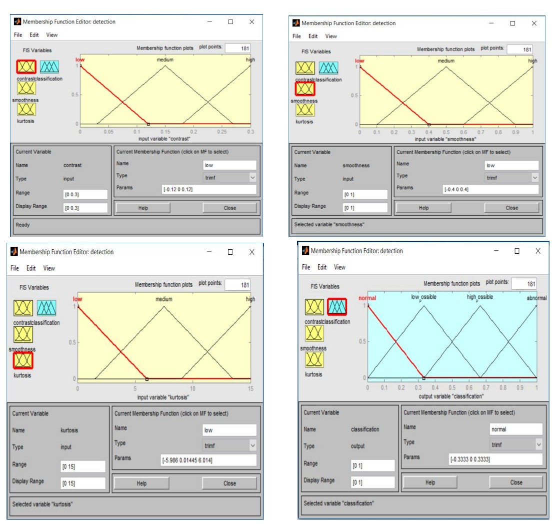


Fig. 5(b) MF editor window

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VI June 2020- Available at www.ijraset.com

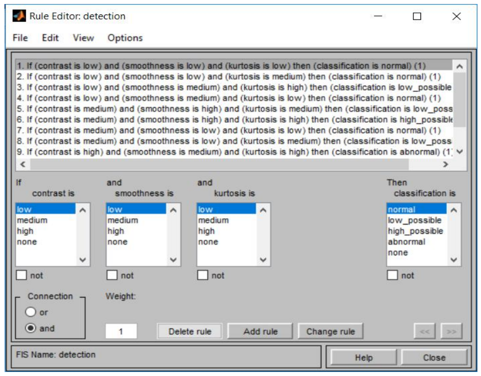


Fig. 5(c) Rule editor window

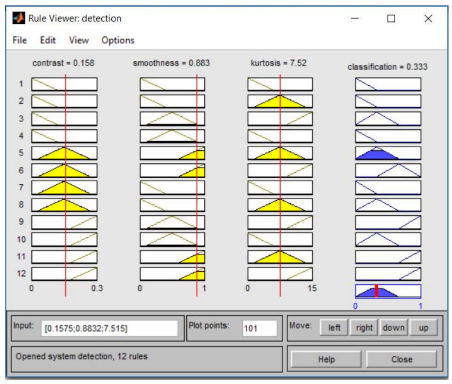


Fig. 5(d) Rule viewer window

B. Output of SVM classifier

The extracted features were fed as input, the output was displayed as Help dialog box in MATLAB.

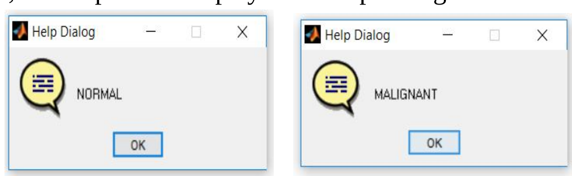


Fig. 6 output for normal and abnormal image

C. Classification Performance

The classification performance of Fuzzy and SVM classifier were evaluated with the parameters like accuracy, specificity and sensitivity.

Accuracy (classification metric) is the number of correct predictions divided by the total number of given samples.

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

Specificity (True negative rate TNR) is a proportion of negative cases that predicts normal.

$$Specificity - \frac{TN}{TN + FP}$$

Sensitivity (True positive rate TPR) is a proportion of positive cases that correctly classify the affected persons.

$$Sensitivity = \frac{TP}{TP + FN}$$

where

TP, TN, FP and FN denotes True Positive, True Negative, False Positive and False Negative.

Statistical measures	Fuzzy classifier	SVM classifier
Accuracy	70%	90%
Specificity	60%	80%
Sensitivity	80%	100%

Table. 2 Parameter comparison for Fuzzy and SVM classifier

V. CONCLUSION

In this work, Fuzzy and SVM classification systems were developed to classify the 5 normal and 5 abnormal (10 cases) thermal breast images. About 13 statistical features were extracted and to be used for classification. For that, these features were given to the input of the classifiers. The classification performance were analysed with 70% accuracy, 60% Specificity, 80% Sensitivity for Fuzzy classifier and 90% accuracy, 80% Specificity, 100% Sensitivity for SVM classifier. From fig. 4 (graphical representation), there is no considerable variation in normal and abnormal parameters. To overcome this, advanced image enhancement techniques can implement.

A. Future Work

The thermogram images should enhance using advanced techniques and further improve the accuracy, sensitivity and selectivity.

REFERENCES

[1] Pavithra .P.S, Ravichandran .K.S, Sekar .K.R and Manikandan .R (2018), "The Effect of Thermography on Breast Cancer Detection," Systematic Reviews in Pharmacy, Vol. 9, No. 1, pp. 10-16.

[2] Vaneesa Lessa and Mauricio Marengoni (2016), "Applying Artificial Neural Network for the Classification of Breast Cancer using Infrared Thermographic Images," Springer Journal, pp. 429-438.

[3] Lashkari .A, Fatemeh Pak and Mohammad Firouzmand (2016), "Breast thermal images classification using optimal feature selectors and classifiers," Journal of Engineering, Vol. 7, pp. 237-248.

[4] Lashkari .A and Mohammad Firouzmand (2016), "Early breast cancer detection in Thermogram images AdaBoost classifier and Fuzzy C-means clustering algorithm," Middle East Journal of Cancer, Vol .7, No .3, pp .113-124.

[5] Sheeja .V, Punitha .N, Sasikala .M (2016), "Cancer detection in Rotational Breast Thermography images using Bi-spectral Invariant features," Journal of Chemical and Pharmaceutical Sciences, Vol. 9, No. 4, pp. 974-2115.

[6] Waheb .A, Mohammad Salim .M, Yunus .J and Nadwa Che Aziz .M (2015), "Tumor Localization in Breast Thermography with various Tissue compositions by using Artificial Neural Network," Conference on Research and Development, research Vol. 1, pp. 4673-9572.

[7] Schaefer .G (2014), "ACO classification of thermogram symmetry features for breast cancer diagnosis," Springer Journal, Vol .9, pp .14-135.

[8] Dinsha and Manikandaprabu (2014), "Breast Tumor Segmentation and Classification using SVM and Bayesian from thermogram images," Vol .02, pp .147-151.

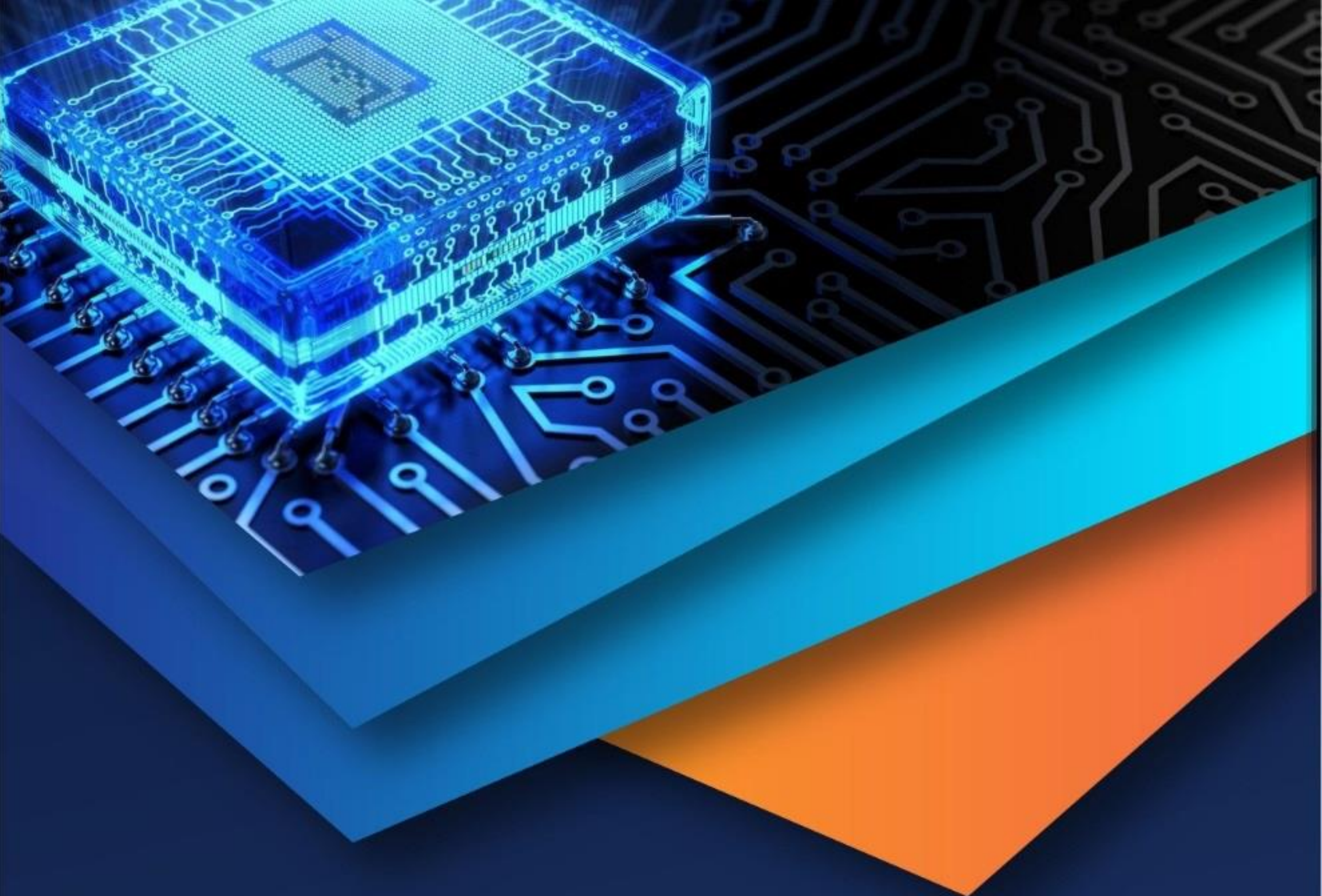
[9] Zaheh .H.G, Haddadnia .J, Hashemian .M and Hassanpour .K (2012), "Diagnosis of breast cancer using a combination of Genetic Algorithm and Artificial Neural Network in Medical Infrared Thermal Imaging," Vol .9, No .4, pp .265-274.

[10] Sandeep Chaurasia, Prasun Chakrabarti and Neha Chourasia (2012), "An Application of Classification Techniques on Breast Cancer Prognosis," Vol. 59, N0. , pp. 975-8887.

[11] Ming-Yih Lee and Chi-Shih Yang (2010), "Entropy-based feature extraction and decision tree induction for breast cancer diagnosis with standardized thermograph images," Springer Journal, pp. 269-282.

[12] Gerald Schafer, Michal Zavisek and Tomoharu Nakashima (2008), "Analysis of Breast Thermograms based on Statistical image features and Hybrid Fuzzy Classification," Springer journal, Vol. 47, pp. 753-762.

[13] Hisao Ishibuchi and Tomoharu Nakashima (1999), "Performance Evaluation of Fuzzy Classifier Systems for Multidimensional pattern classification Problems," IEEE Transactions on Systems, Vol.29, N0. 5, pp. 1083-4419.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY