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DIAGNOSIS AND CLASSIFICATION OF BREAST CANCER FROM THERMOGRAM IMAGES USING TEXTURE FEATURE AND ARTIFICIAL NEURAL NETWORK (ANN)

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Abstract:

Early diagnosis of breast cancer is very vital for the treatment procedure and drastically save the cost and pain of treatment process. There are various techniques such as mammography; ultrasound and MRI are in use for breast cancer diagnosis. Mammography is considered the gold standard for detection of breast cancer but still has certain sensitivity and specificity. Whereas, infrared thermography has advantages over other methods, in terms of radiation risk, high sensitivity and specificity rate. In our work, texture features were extracted and classification was done using Artificial Neural Network (ANN) under MATLAB (version R2013a (8.1.0.604)). The system includes the steps of image acquisition, feature extraction, classification (training and testing). The proposed system achieved overall classification accuracy of 91.66% with Sensitivity 86.66% and Specificity 95.23% for total test samples of 36 images taken from Thermogram Center data.

Key Words: Breastcancer, Thermography, Infrared Thermal Imaging, Texture Analysis & Classification

Introduction:

The breast cancer has high incidence in recent years and increase significantly which is leading cause of death worldwide.In India nearly six percent of deaths are due to breast cancer. One out of every 22 women in India is diagnosed with breast cancer. Numerous techniques like MRI, ultrasound, mammography are used in diagnosis of breast cancer where the performance relates with the density of breast. Thermography or infrared imaging is a non-invasive, non-contact system of determining body temperature by measuring infrared radiation emitted out by the body surface which is pain free, fast, low cost and sensitive method. Various age group women can use breast thermography irrespective of the breast density.Temperature distribution patterns in thermographycause the physical interpretation of tissues which results suspected areas of cancer tissueeven when anatomical abnormalities are not present and the tissue appearshealthy. The basic principle of thermography is the metabolic activity and vascular circulation in both healthy tissue and the area surrounding a developing breast cancer(cancerous) are always maximum than in normal breast tissue.The variations of temperature in the body surface after a coldstimulation to patients have been undertaken whichwould be advantageous to physicians, specially forearly disease diagnosis.

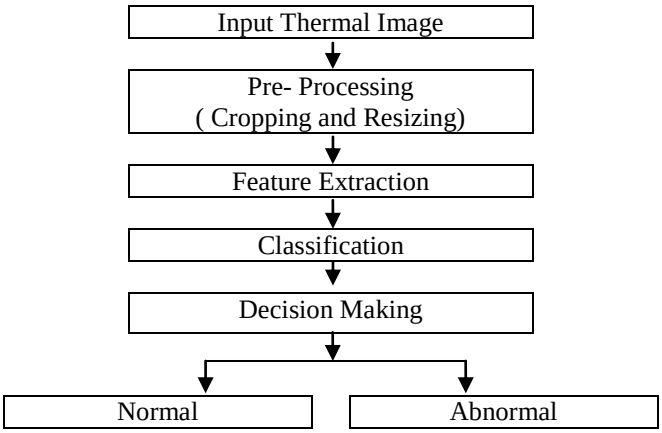
Stimulation of the nervous system causes a constrictionof the normal blood vessels in the breast. Consequently, the thermal subtraction provides us thepossibility of isolating the vessels that supplynutrients to the tumor and ultimately suspects that a cancerous tumor may bepresent. It is difficult for radiologists to provide accurate and uniform evaluation of breast cancer through human visual system.With the advances of computer technology; radiologists have an opportunity to improve their image interpretation using computer capabilities that can enhance the image quality of thermogram. Image processing and intelligent systems are main streams of computer technologies that explored in the development of computer aided thermography systems. Earliest signs of breast cancer can be observed in the temperature spectrum due to sensitivity of thermography.

Thermogram breast cancer images gives out the image in RGB forms which is determined based on the thermal range of surface tissue. The thermal pattern also indicate cancer infection, inflammation and surface lesions on the thermal image.

Qualitative and quantitative methods are used to analyse and determine the resultant texture form values of image. Quantitative method gives the result value based on the general prediction of the image. Whereas, qualitative method analysesthe image through feature values which is more precise. The accurate interpretation of thevalues gives out the physicians in early detection of the breast cancer and early treatment procedures which can save the patient from severe damage.

Texture features which are obtained from the image indicate the pattern of tissues. Various features such as mean, kurtosis, skewness, energy and such are acquired. These values are more sensitive in result determination where the image quality is revealed.

Methodology:



Measurement Space:

This space involves with the image values where the values are measured from the cropped malignant and benign areas of thermogram image. This value gives out the basic values of the thermogram image. This reveals the original image measurements.

Feature Space:

Here the features of the thermo gram images are extracted using GLCM features using various formulations. In this space the feature specifications are noted out where the mean, average, energy and other such results are determined.

Decision Space:

The extracted feature are classified with artificial neural network where the images are trained with special classifiers .Here Delta learning rule is applied to obtain the resultant values with accuracy ,sensitivity and specificity.

Feature Extraction:

Feature extraction is a method of capturing visual content of an image .The objection of feature extraction process is to represent raw image in its reduced from to facilitate decision making process such as pattern classification. A variety of technique used for texture feature extraction such as intensity histogram, co-occurrence matrix and intensity based features. Texture features are extracted from the cancerous and healthy regions of the cropped thermogram image. Feature extraction step is important step to get high classification rate. A set of features are extracted in order to allow a classifier to distinguish between normal and abnormal pattern. The abnormality can be identifier on the basis of textural appearance. Extracted features are used in neural classifier to train it for the recognition of particular class either normal or abnormal. The ability of the classifier of assign the object to the correct class dependent on the extracted features.

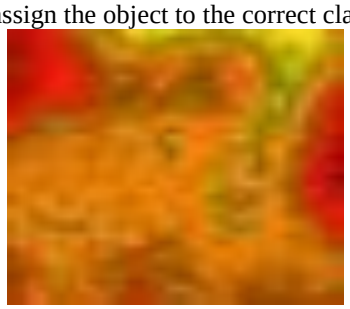


Figure 1: Cancerous region of thermogram image

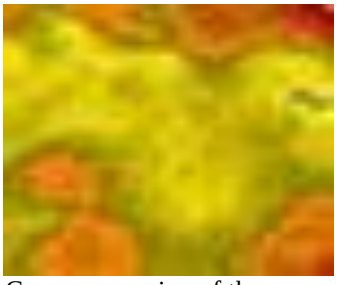


Figure 2: Cancerous region of thermogram image

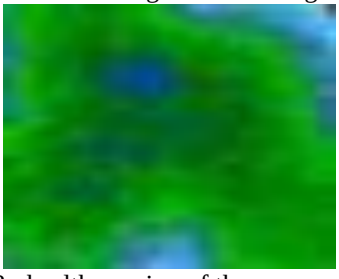


Figure 3: healthy region of thermogram image

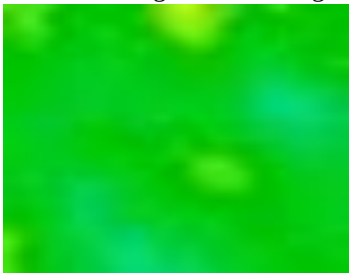


Figure 4: healthy region of thermogram image

Texture Feature:

It is the set of metrics calculated designed to quantify the perceived texture of image. Also it gives the information of spatial arrangement of colorand the contents of the image or intensities in an image .Mainly it describe the features of texture ie., Coarseness and regularity. Gray level cooccurance matrices measure is the most important measure used to describe the texture.

Moments:

An image moment is a particular weighted average of the image pixels intensities usually to have some attractive property .It is useful to describe objects after segmentation. The moments include area, centroid and orientation informations.

GLCM:

Gray level cooccurance matrix is the statistical method of examining texture in consideration of spatial relationship of pixels. It characterize the texture of an image and calculates how often pairs of pixel with specific values and spatial relationship occur in an image. The features such as energy, entropy, correlation, homogeneity are calculated.

After feature extraction, by using normalization techniques, the values are tabulated. As a result of this technique, most effective features are predicted among the calculated features. The features are,

- ✓ Average Red Values
- ✓ Average Green Values
- ✓ Average Blue Values
- ✓ Skewness
- ✓ Kurtosis
- ✓ Fourier Dc
- ✓ Fourier Ac
- ✓ Homogeneity
- ✓ Maximum Probability
- ✓ Elememts Difference Moment
- ✓ Inverse Difference Moment
- ✓ Entropy
- ✓ Angular Second Moment

Skewness:

Skewness is a measure of the asymmetry of the probability distribution of a real-value random variable. Skewness characterizes the degree of asymmetry of a pixel distribution in the specified window around its mean. Skewness is a pure number that characterizes only shape of the distribution. The formula for finding skewness is given in the below,

$$skew = E(\frac{X-X}{\sigma})^3$$

Kurtosis:

Kurtosis is a measure of how outlier-prone a distribution is the kurtosis of the normal distribution is 3.Distributions that are more outlier-prone than the normal distribution have kurtosis greater than 3;distribution that are less outlier-prone have kurtosis less than 3.

$$kurtosis = E(\frac{X-X}{\sigma})^4$$

Homogeneity:

Homogeneity implies consistency in back of variations between the items being compared over a long period and across a wide range.

$$homo = \sum_i^n \sum_j^n \frac{cij}{1+mod\ (i,j)}$$

Maximum Probability:

Maximum probability is used to estimating the parameters of a statistical model. When applied to a data set and given a statistical model, it provides estimates for the models parameters.

$$\max\ prob = \frac{\max\ (cij)}{N}$$

Element Difference Moment:

It measures the texture of the image in different orders of 2 and 3.The adjacent parameters of the image are measured.

$$edm2 = \sum_i \sum_j (i-j)^2\ cij$$
$$edm3 = \sum_i \sum_j (i-j)^3 cij$$

Inverse Difference Moment:

It is a measure of image texture. IDM ranges from 0.0 for an image that is highly textured to 1.0 for an image that is untextured.

$$idm2 = \sum_i \sum_j \frac{cij}{(i-j)^2}$$
$$idm3 = \sum_i \sum_j \frac{cij}{(i-j)^3}$$

Entropy:

Entropy is the average amount of information contained random variable. Entropy in an information sense is a measure of the unceratinity associated with random variable .Entropy in an information sense is a measure of unpredictability.

$$E = -\sum_i \sum_j c\ i; \log_2 c\ ij$$

Angular Second Moment:

ASM calculates the rotational acceleration using moment of inertia in physics.

$$asm = \sum_i^n \sum_j^n c(i,j)^2$$

Artificial Neural Network:

Artificial Neural Networks are relatively crude electronic models based on the neural structure of the brain. The brain basically learns from experience. It is natural proof that some problems that are beyond the scope of current computers are indeed solvable by small energy efficient packages. This brain modeling also promise a less technical way to develop machine solutions. This new approach to computing also provides a more graceful degradation during system overload than its more traditional counterparts.

Delta Learning Rule:

Deltarule which is gradient descent learning rule which updates the weight of input to artificial neuron in single layer neural network .It is the general back propagation algorithm form. The derivation is different from Perceptron update rule. The delta rule minimizes the error in the output network.

Results and Discussions:

In our work we aim to make sure that it is possible to use breast thermograms for tumor detection using GLCM features extracted from each thermography image with delta learning rule. Using delta learning rule and 17 GLCM features derived from each thermogram image the processes is accomplished.The thermography is based on highermetabolic activity and blood flow surroundingthe cancerous tissue rather than normal tissue.Infrared thermography is promising technology forbreast cancer detection. This technology can beused as an imaging technique to improve theefficiency of detecting breast cancer andcomplement mammogram results. The accuracy ratio of 91.66%, with sensitivity (True positive rate) ratio of about 86.66% and specificity (True negative rate) ratio of about 95.23%.

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