International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-9 Issue-2, December, 2019

Detection of Breast Cancer by Thermal Based Sensors using Multilayered Neural Network Classifier

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Abstract*: Consideration of public health problem issues, one of the most common diseases in public is cancer. Most of the women population is suffering from breast cancer which is the most well known appearance of cancer in metropolitan cities of India and abroad. There many number of imaging modalities to diagnose cancerous cells. Among those, mammography is alone an imaging modality which diagnoses the breast cancer at an early stage. Furthermore, this modality involves X-rays which are more harmful to human health and make the patient inconvenience. Through the mammogram, doctors can analyze, estimate and evaluate the cancer stage so that doctors can give better and correct treatment to the patients. With this mortality and death rates can also be diminished up to some extent. In this paper, the author proposed an intelligent system to identify and find out the severity of breast cancer. By using a thermal based sensor which is of negative Temperature Coefficient (NTC) available with C-MET Thrissur which replaces Mammography. The stage at which the cancer is progressing is classified with the help of Intelligent System Algorithms which works on the temperature data obtained from the thermal device. The data is pre-processed and applied to multilayered backpropogation neural network model. The neural network classifies the preprocessed images into normal, benign and cancer. The output of the network is presented to the doctors through graphs and displays.

Keywords: breast cancer; thermistor sensor; mammography; NTC

I. INTRODUCTION

In India, breast cancer cases are increasing every year and there is steady rise in young women too. According to ICMR, in metropolitan cities, the occurrence of breast cancer is doubled in two decades. It is the most common and dangerous cancer in women throughout the world, and is probably estimated of around 14% of cancer deaths in women. The universal burden of breast cancer is calculated by economic costs, incidence and mortality is indicated by public health data (2). Early detection of cancer will enable the doctors to give suitable medicines to the patients and cure the disease. A Computer Aided Detection and Analysis (CADA) system proposed method which could be very useful to doctors to determine the possibility of a tumor, which otherwise they would have unnoticed through Mammogram test.

An abnormal changes or wide growth of cells can result in cancer. Over time, mutations or abnormal changes in cells may happen. These changed cells acquire the capability to separate without any control thereby generating additional number of cells called tumor. An unrestrained growth of tissue cells in breast is named as breast cancer.

A tumor can be of two types: benign and malignant. Benign tumors are not harm to human health even though they may appear as cancerous cells. Malignant tumors are dangerous and sometimes it may cause to death too if the severity is more.

There are many imaging techniques (1, 8) that are offered to identify the existence of cancerous cells in breast. The one technique is mammography, but there is a disadvantage is that it requires breasts compression and also it may cause patient inconvenience while the patient is exposure to x-rays and causes risk in patient's health. In addition to that, the screening cost is also expensive (3). Few Visualization and Non- Visualization techniques can be used to detect breast cancer and utmost used techniques are:

i). Visualization Techniques

a) Magnetic Resonance, b)Mammography

c) Ultrasonography

ii). Non-Visualization Techniques

a) Biopsy b) BRCA1/BRCA2 Gene transformation Detection.

The above all techniques are costly and these tests may not be done at residence because of large equipment (8).

II. RELATED WORK

Dheeba. J comes up with new classification method using Support Vector Machine to detect micro calcification group in digital mammograms. Data classification may be a common mechanism in machine learning. SVM is considered as a supervised learning classifier to detect micro calcification at every pixel spot in mammogram image.

Revised Manuscript Received on December 30, 2019.

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Anuj Kumar Singh and Bhupendra Gupta proposed an algorithm to detect the presence of cancer in a particular area in ground truth image by using Max-Mean and Least Variance technique. The authors made successful attempt in segmenting the cancer region from a mammogram which is their Region of Interest. (5).

Mohamed Abdel-Nasser, Antonio Moreno and Domenec Puig proposed a new technique called dynamic thermography to identify the changes in temperature of breasts using learning techniques (9) called learning-to-rank (LTR) and texture analysis methods.

Nadeem Tariq (10) investigated and proposed a Computer Aided Diagnosis (CAD) system to differentiate non cancerous and cancerous cells in a mammogram. The texture features from mammogram were calculated using GLCM, the most required features are chosen and applied to a network for training and validation.

III. METHODOLOGY

A. Work flow or Data Flow of proposed method

The research work deals with different stages to classify the three classes with greater accuracy with less performance time. The step by step procedure to detect breast cancer at early stage is shown below:

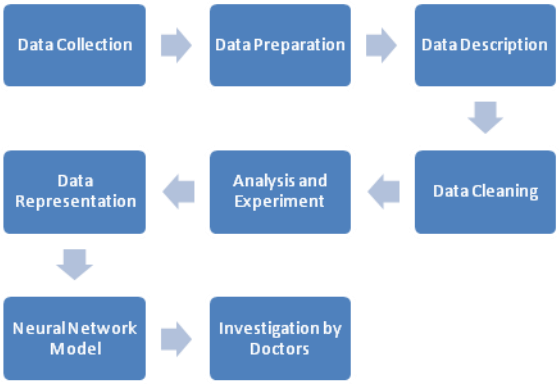

Figure 1. Step by step procedure to detect breast cancer.

At first, the data has been collected and made the data ready for analysis by doing data pre processing. After data pre-processed, the same data has represented by converting into binary form to feed the data into a neural network model.

B. Circuit Design and Thermal sensor placement

The analysis of skin temperature of breast and the stage of breast cancer was carefully done (7). For successful conduction of the experiment, both hardware circuit and software are developed. Hardware circuit involves placing of several thermal based sensors on brassiere to detect temperature variations from various places of the women breast. The NRI Hospital, Guntur, Andhra Pradesh, India, the multiple thermistor sensors are placed on the patients for screening of breast cancer (4). This device will generate temperature data at 64 points for each patient. The data accessible from the NRI Hospital is fed into the proposed system after required data pre-processing.

C. Experimental Setup to detect breast cancer

The temperature data in terms of resistance is obtained from the thermistor probes. This data are acquired, conditioned, digitized and analyzed in the proposed system and the temperature data thus obtained is given to software techniques residing in a computer via proper communication interface using standard protocols in real time. The temperature data thus, captured is stored in a database for historical purposes and is displayed for reference with colour using human machine interface components. The intelligent system strategy with different methods contains the display which will provides all information about the early detection of breast cancer. Each method output will be represented in the display and temperature information will be provided in terms of value as well as colour, chart, display as shown in figure 2 and 3. From the color indication, the user could easily identify the patient weather she belongs to the classes of malignant, benign and normal. A red pattern is identified for malignant status, green is given for normal status and benign status will be indicated with a yellow color. The report generation is also possible by computing process.

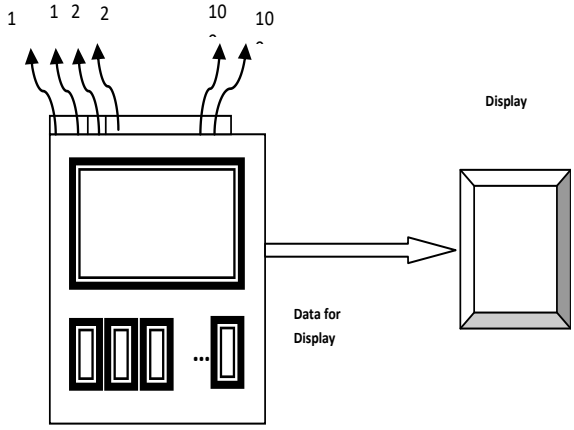

Figure 2. Experimental setup to display temperature

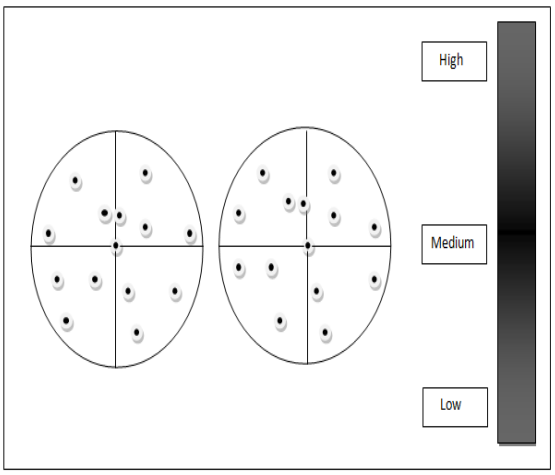

Figure 3. Chart and color indication of temperature

D. Data Collection

The behavior of human beings is studied in detail. If a woman is having breast cancer, then the affected portion of the breast will exhibit a higher temperature which is of the order of +4oC when compared to remaining parts of the body.

We have to measure this deviation of temperature by using a suitable thermal sensor which exhibits NTC and provides high sensitivity and resolution. A total of 64 such thermistor sensors are embedded on the left and right breasts of the woman and the temperature signals are obtained by a suitable data acquisition system.

E. Data representation

In the data representation, the collected data set has to be converted into binary form by using various data representation techniques like graphical techniques and non graphical techniques. Each technique result will become input to the soft computing techniques like Genetic based Neural Network, Artificial Neural Network, Fuzzy Inference Systems (ANFIS), Support Vector Machine algorithms etc.

F. Neural Network Model

A soft computing system named computer aided diagnostic system using multi layer neural networks for the classification of mass characterization in temperature data, a model is proposed with different learning rules of 64 various inputs, two hidden layers of 63 inputs and output neurons of three numbers are framed as architecture of neural networks. Additionally bias will be included by the output neurons and hidden neurons. Figure 4 illustrates the learning method of cancer detection using neural network classifier.

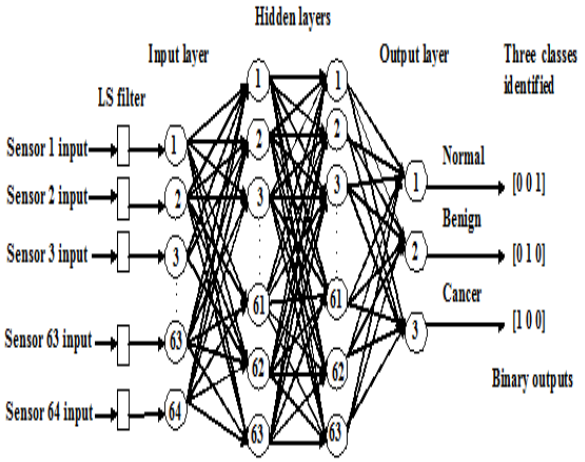

Figure 4. Multi- layered Neural Network Classifier

Multi layer Back propagation algorithm works towards for minimizing the cost function by adjusting biases and weights of the network. The gradient of the cost function determines the level of adjustment with respect to those parameters. The working of back propagation algorithm is as follows:

a. Initially choose random weights of the network.

b. Algorithm contains four steps: i) Calculation of feed forward network ii) back propagation to the output layer iii) back propagation to hidden layer iv) update weights. When the error function value becomes small, the algorithm is stopped.

Lastly, to give out the outstanding diagnosis of the patient who is suffering from cancer, our proposed method provides more accuracy rate of classification. This can be achieved by measuring the Mean Square Error. It is a quality measure of an estimator. It is always being positive and values nearer to zero are considered as best. The general equation for MSE is given below:

$$MSE = \frac{1}{n}\sum_{i-1}^{n}(yi - yi^{\wedge})^{2} \quad (2)$$

Before feeding the data, optimal filtering is done which is plotted and explained as shown in figure 5.

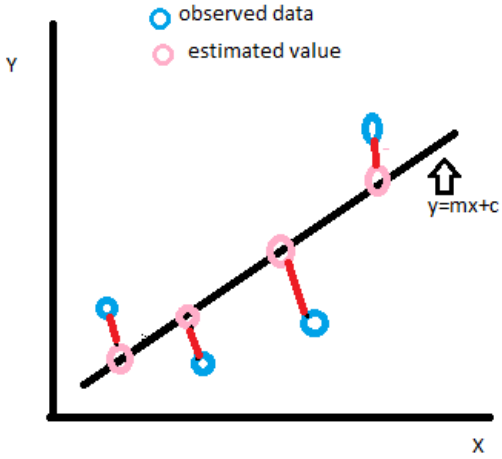

Figure 5. Optimal filtering of observed data

The pink dots are the points on the prediction (black color) line in the above graph.

The black line is prophecy line which directs or moves all the way through dots and put these dots in better. Predicted (pink) points are placed on the black line.

The error is represented with red line which is pointed in between every pink dot and the blue dot. The detachment from the pink dot to its predicted dot is considered as error.

IV. RESULTS AND DISCUSSION

The below graph indicates that best validation performance at 12 epochs. The red line indicates for the tested data, blue line gives information about the trained data, green line gives information about the validated data and dotted line shows the best. From the graph we can conclude that the tested data is very close to the best i.e., the dotted line as the numbers of iterations are increasing.

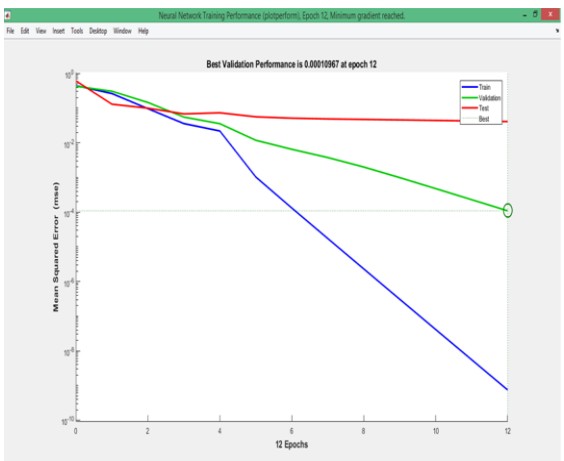

Figure 6. Best validation performance

The graph shown below presents information of a neural network training regression at 12 epochs at which minimum gradient is reached.

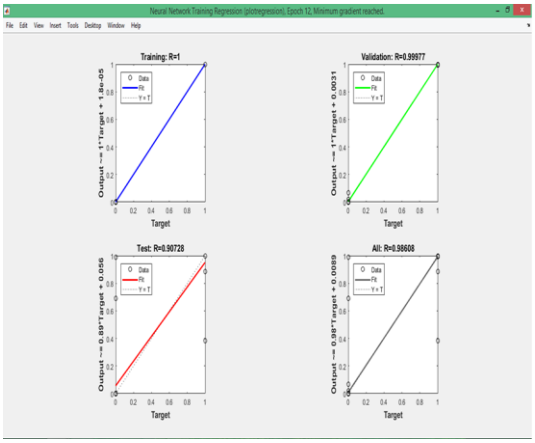

Figure 7. Regression plot at 12 epochs

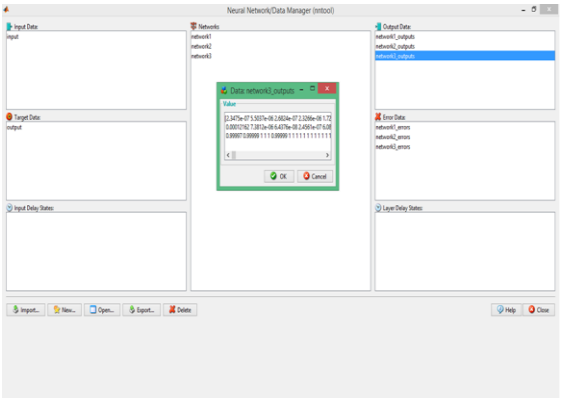

Figure 9. Output values of the network.

V. CONCLUSION

From this research work, the authors conclude that by using several thermal based sensors, breast cancer was detected at an early stage without any inconvenience to the patients. The thermal based sensors can have the capability to sense the variations in temperature or heat that are generated from various places of the women breast. The readings from all the sensors are collected, preprocessed and represented for neural network model for analysis. To make sure that the accurateness and performance of the sensors, the analyzed data is compared and verified. In addition, the proposed method of designing and placing of the thermal sensors on brasserie provides safety for woman.

ACKNOWLEDGMENT

Authors convey their gratefulness to NRI Hospital, Guntur, Andhra Pradesh, India for supporting to do this experiment to test on patients.

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