Tumor Detection Using Trapezoidal Function and Rayleigh distribution.

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Abstract: Breast cancer is one of the most common cancers worldwide. In developed countries, among one in eight women develop breast cancer at some stage of their life. Early diagnosis of breast cancer plays a very important role in treatment of the disease. With the goal of identifying genes that are more correlated with the prognosis of breast cancer.

An algorithm based on Trapezoidal and Rayleigh distributions property is used for the detection of the cancer tumors. Fuzzy logic and markov random fields work in real time. We also try to show its performance by comparing it with the existing real time algorithm that uses only markov random fields. This is not only suitable for the detection of the tumors, but also suitable for various general applications like in the detection of object in an image etc.

Keywords: Tumor detection, markov random field, Rayleigh distribution, Image Segmentation, Fuzzy Logic.

1 INTRODUCTION

Breast Cancer is one of the leading causes of cancer related deaths in women. There are available different methods for the detection of cancer tumors, these methods are used for the diagnosis of cancer in women at early stages. This can be a difficult task due to the irregular size and shape of the tumor. One of the methods used for tumor detection is based on Computed Tomography image. In this method we use the probabilistic pixel selection approach. The segmentation process here is performed in Two dimensional slice to slice basis. The segmented slices are stored in the form of a data set. In this method we use different seed points for different test sets. This method proved to be efficient for some data sets where as for some data sets it has some disadvantages. The accuracy of the tumor detection based on the dataset we are going to test. Computerized image based detection method can also be used for the tumor detection. In this method we go for Lymphocytic Infiltration. This LI functions as a potential anti-tumor mechanism. In this method pathologists and oncologists go for manual detection of tumors. Here quantitative features are derived from graphs using the methods like Voronoi Diagram, Delaunay triangulation and minimum spanning tree. The evaluation methods that are used here are Hausdorff Distance, Cross Validation using SVM classifier, VZ Texton based classifier. This method is being automated by using CADx system. Here we use region growing algorithms and subsequent MRF based refinement to isolate LI from the surrounding BC nuclei, baseline level of Lymphocytes. Segmentation of the tumor can also be performed using Gaussian Markov Random Fields. In this method the entire image is assumed such that it is having only two classes and it is modeled using Rayleigh distribution. The encoding for spatial interactions between pixels, its parameters can be easily estimated using Least squares. This method is suitable for real time applications. The segmentation performed here is supervised segmentation, in which it is

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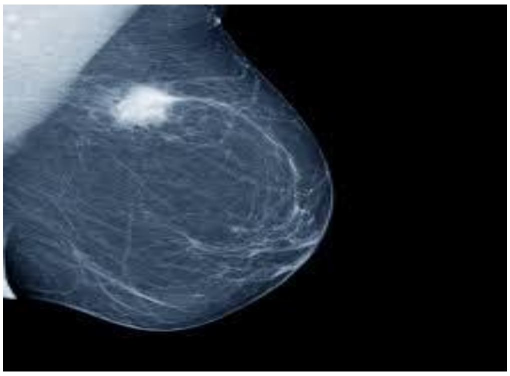

divided into two phases. First phase is feature selection and second phase is testing the selected features using the segmentation algorithm. The

Fig 1: Typical image of a tumor.

detection accuracy of this method is good compared to other techniques that are available. The error rate is also less for this method.

In this paper for the detection of tumor we use an algorithm developed by using simple Trapezoidal and Rayleigh distributions. The aim of this study is to develop a robust algorithm for detection of tumors. We use a real time segmentation algorithm for this. Markov Random Fields helps us to deal with the uncertainties in an image by means of explicitly defining the spatial interactions between pixels as a probability distribution. The image is assumed such that it is having only 2 classes and it is modeled using Rayleigh distribution. Rayleigh distribution is one of the simplest MRF that is suitable for encoding spatial interactions between pixels and can be easily estimated using least squares. Fuzzy logic has been applied to many fields, from control theory to artificial intelligence. This Fuzzy logic uses edge detection method to find the tumor edge pixels by applying the rules to each pixel along with its 8–neighborhood pixels. Before applying the rules, each pixel is categorized into a "white" and "black" pixel using the triangular membership function.

The rest of paper is organized as follows. Section 2 gives basic definitions and notations of MRF theory. Sect 3 describes about Rayleigh distribution. The fuzzy logic with edge detection is described in Sects.4. The Image model is represented in sect 5. The performance comparison for existing and proposed methods are discussed in Sect.6 followed with conclusion.

2.RAYLEIG DISTRIBUTION FUNCTION:

A Rayleigh distribution is often observed when the overall magnitude of a vector is related to its directional components. One example where the Rayleigh distribution naturally arises is when wind velocity is analyzed into its orthogonal 2-dimensional vector components. Assuming that each component is uncorrelated, normally distributed with equal variance, and zero mean, then the overall wind speed (vector magnitude) will be characterized by a Rayleigh distribution. A second example of the distribution arises in the case of random complex numbers whose real and imaginary components are independently and identically distributed i.e. Gaussian with equal variance and zero mean. In that case, the absolute value of the complex number is Rayleigh-distributed. The distribution is named after Lord Rayleigh.

The probability density function of the Rayleigh distribution

$f(x,\sigma) = \frac{x}{\sigma^2} e^{-\frac{X^2}{2\sigma^2}}, x \ge 0$

where $\boldsymbol{\sigma}$ is the scale parameter of the distribution. The cumulative distribution function

is $F(x) = 1 - e^{-\frac{X^2}{2\sigma^2}}$ for $x\epsilon[0,\infty)$

Consider the two-dimensional vector

Y = (*U*; *V*) which has components that are Gaussian-distributed, centered at zero, and independent

$$f(x,\sigma) = \frac{1}{2\pi\sigma^2}\int_{-\propto}^{\propto} du \int_{-\propto}^{\propto} dv\; e^{-\frac{u^2}{2\sigma^2}}\, e^{-\frac{v^2}{2\sigma^2}}\, \delta\Big(x - \sqrt{u^2+v^2}\Big),$$

by transforming to the polar coordinate system one has

$$f(x,\sigma) = \frac{1}{2\pi\sigma^2}\int_{0}^{2\Pi} d\phi \int_{-\propto}^{\propto} dr\; \delta(r-x)\; r e^{-\frac{r^2}{2\sigma^2}}\, e^{-\frac{v^2}{2\sigma^2}} = \frac{x}{\sigma^2} e^{-\frac{X^2}{2\sigma^2}}$$

which is the Rayleigh distribution. It is straightforward to generalize to vectors of dimension other than 2. There are also generalizations when the components have unequal variance or correlations.

An application of the estimation of σ can be found in magnetic resonance imaging (MRI). As MRI images are recorded as complex images but most often viewed as magnitude images, the background data is Rayleigh distributed. Hence, the above formula can be used to estimate the noise variance in an MRI image from background data.

3. FUZZY LOGIC

3.1 Definition Of Fuzzy Logic:

Fuzzy logic is a mathematical logic that attempts to solve problems by assigning values to an imprecise spectrum of data in order to arrive at the most accurate conclusion possible. Here, the fuzzy logic is used to conclude whether a pixel is an edge pixel or not. The proposed technique begins by fuzzyfying the gray values of a pixel into two fuzzy variables, namely the black and the white. Fuzzy rules are defined to find the edge pixels in the fuzzified images.The term "fuzzy logic" was introduced with the proposal of fuzzy set theory by Lotfi A. zadeh. Fuzzy logic has been applied to many fields, from control theory to artificial intelligence. This Fuzzy logic uses Edge detection method to find the weed edge pixels, by applying the rules to each pixel along with its 8-neighbourhood. Before applying the rules, each pixel is categorized into a "white" and "black" pixel using the triangular membership function.

3.2 Fuzzy With Edge Detection:

Edge detection plays a vital role in many of the applications of image processing such as pattern recognition and image segmentation. Edges correspond to sharp variations of image intensity and convey vital information in an image. Edges are formed from pixels with derivative values that exceed a pre-set threshold. Edge detection not only extracts the edges of the interested objects from an image, but it also forms the basis for image fusion, shape extraction, image matching, image tracking

Normally, the edge detection methods use the gradient of images and arithmetic operators. The most popular edge detection methods, such as Sobel, Prewitt, Roberts etc. detect edges using a first-order derivative of intensity since they consider edges to be a set of pixels where there is an abrupt change in the intensity of the gray level. These edge detection methods do not consider the neighborhood of a pixel, while in our proposed method plays an important role in edge detection.

On the other hand, fuzzy logic employs simple if-then rules, which do not require any thresholding or complex gradient based calculations. Thus, an edge detection method that is based on fuzzy logic is proposed in our project.

Here are a lot of ways to detect edges using fuzzy image processing. But the simplest way is to fuzzify the image. This involves finding the membership value of each pixel for a particular set and then applying the defined rules to the fuzzified image to find the edge map. If the information in a database is inexact, incomplete, or not entirely certain, then the systematic use of fuzzy logic becomes practically indispensable. In many image processing applications, the image information that is to be processed is uncertain and imprecise. In the proposed approach, the question of whether a pixel is darker or brighter comes under the realm of fuzzification. The darker pixels are placed in the black class, whereas, the brighter ones are put in the white class. In order to fuzzify the image, the membership of each pixel is found by using the triangular membership function. The membership function of an element defines the degree to which that element belongs to the fuzzy set. The value of the membership function always lies between [0…1].

3.3 Fuzzy Rules:

Human beings make decisions based on rules. The decision and the means of choosing that decision are replaced by fuzzy sets and the rules are replaced by fuzzy rules. A fuzzy rule is defined as a conditional statement in the form of:

IF x is A THEN y is B

Where x and y are linguistic variables, A and B are linguistic values that are determined by fuzzy sets on the universe of the discourse X and Y, respectively. The fuzzy rules used in the proposed edge detection approach take into account the linguistic values of the 8-neighborhood of the pixel that is under consideration. Here, the linguistic values can be white or black.

The fuzzy rule is a control system that is used to infer decisions from a knowledge base. The knowledge base to infer the edge pixel in an image is the pixel with its 8-neighborhood. The decision whether each pixel is an edge pixel or not is made by using the fuzzy rules that are applied to the 8-neighborhood. The pixels in the 8-neighborhood of a pixel may be black or white.

4.TRAPEZOIDAL FUNCTION:

The trapezoidal function is defined by minimum, lower mode, upper mode, and maximum parameters. The generalized trapezoidal distribution adds three more parameters: the growth rate, decay rate, and boundary ratio

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parameters. Van Dorp and Kotz[2] and van Dorp and colleagues[1] formally describe the generalized trapezoidal distribution, representing the minimum, lower mode, upper mode, maximum, growth rate, decay rate, and boundary ratio with parameters a; b; c; d; m; n; and _, respectively. The probability density function of the generalized trapezoidal distribution with parameters a; b; c; d; m; n; and _ is given by:

$$f(xa,b,c,d) = \begin{cases} o, & if\ x < a \\ {(x-a)}/{(b-a)}, & if\ a \le x \le b \\ 1, & if\ b < x < c \\ {(d-x)}/{(d-c)}, & if\ c \le x \le d \\ o, & if\ d < x \end{cases}$$

Where x = variable , a,b,c,d are parameters.

The trapezoid package provides functions for the probability density function (dtrapezoid), cumulative distribution function (ptrapezoid), quantile function (qtrapezoid), and random generation (rtrapezoid). The parameters a; b; c; d; m; n; and _ are specified by the arguments min, mode1, mode2, max, n1, n3, and alpha, respectively. The argument names were chose into avoid conflicts with names that commonly have specific meaning in R functions, such as c and n.

5.IMAGE MODEL:

Tumor can be detected by using the Rayleigh distribution but, this approach cannot detect the noisy images and so to overcome this drawback, we developed here a new algorithm that uses edge detection with fuzzy logic along with Rayleigh distribution property.

In this newly developed algorithm first we take an RGB color image of size MxN and convert it to grayscale image. Then apply the fuzzy logic. For this we need to take histogram of the grayscale image. Based on this we have to select the fuzzy variables 'a' and 'c' manually. Now apply the fuzzy rules. Then convert the matrix image into grayscale image.

Now Rayleigh distribution property is to be applied. For this every time take two 3x3 matrices and find the absolute difference between the pixels of two matrices. If it is equals to 1 then compute s. Otherwise compute s1. Combining s and s1 calculate new matrix .

Then convert this into grayscale image and finally we get an output image which consists of tumor only. This approach can even detect the images that are corrupted by noise.

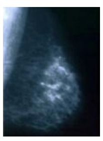
Performance Measurement:

To compare the performance of the proposed method with the existing method, here we add noise for both existing method and the proposed method.

1. Salt & Pepper noise.

After adding these noise we compare the original image with the noise added image. Now draw the graph for noise by noting their values. This process is same for both existing and proposed methods. Their results are as shown in below figures.

Table 1: Comparison of outputs of Rayleigh distribution and Fuzzy Logic Method with Different Threshold Value.

Original Image	**GMRF Output**	**Rayleigh distribution with Fuzzy Logic Output**	**Threshold Value for Fuzzy Logic (a, c)**
			60,250

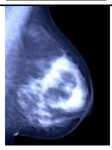
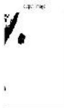
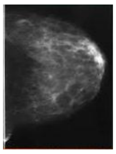
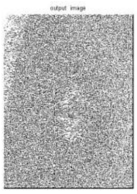
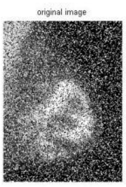
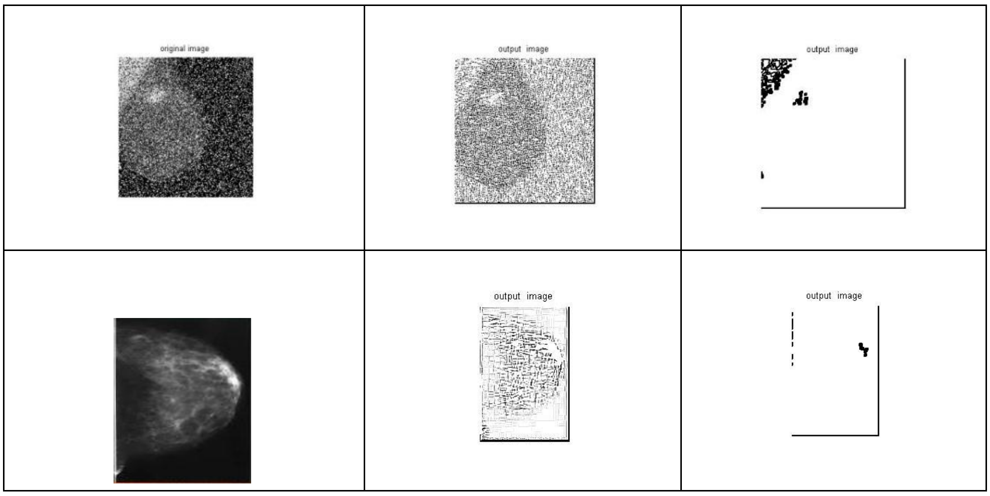
			30,250
			145,235
			145,255
			130,250

Table2: Comparison Of Outputs Of GMRF and Rayleigh Distribution With Fuzzy Logic Method With Salt & Pepper Noise.

Original Image	**GMRF Output**	**Rayleigh distribution with Fuzzy Logic Output**
		
		
		



6.Conclusion:

This project can successfully detect the tumor which can be used in medical dia

gnosis. So through this project we can clearly show that our proposed method will give satisfactory results compared to the existing method. And also this is suitable for detection of images that are corrupted by noises, Moreover this project is suitable for various general purpose applications as said previously also.

The future scope of this work is automatic selection of the threshold values.

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