DIAGNOSIS OF NEOPLASM USING FUZZY LOGIC AND GMRF

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Abstract:
Breast cancer is one of the dangerous cancers in the world related to deaths in women. In some developed countries, among eight of one woman was developed the breast cancer at certain stage of their life. In early stage diagnosis of breast cancer play an important role in treatment of disease. The goal of identifying the genes that are more correlated with the prediction of breast cancer. Computer tomography scan is used to identify breast cancer tissue in the form of image. Depends on an algorithm of fuzzy logic and GMRF property used for the diagnosis of cancer tumor. A Fuzzy logic and Markov random fields works in real time only. Try to display the execution of tumor by comparing proposed algorithm with existing real time algorithm that uses only Markov random field. This is not only applicable for the diagnosis of tumor, but also applicable for the many general applications like detection of object in an image etc.

Keywords- Tumor, GMRF, Fuzzy logic, segmentation

I. INTRODUCTION:
Breast cancer is one of major cause of cancer related to deaths in women. Different methods are available for the detection of tumor causing cancer. Those methods are used for the detection of cancer in women at early stage. Detection of cancer is very difficult due to non-uniform size and shape of the tumor. Image captured from computed tomography scan. One of the methods used for tumor detection depends on computed tomography image. Within this method, we use probabilistic pixel selection approach. Here the segmentation process is performed in two dimensional slices – to – slice manner. Segmented slices are stored in the form of data sets. In this method, for many tests sets various seed points are used. Some data set had proved to be efficient whereas some data sets have disadvantages. Based on the data sets we are going to test the accuracy of tumor detection.

One of the methods used for the diagnosis of tumor is depends on the Computer Tomography image. Here we go for lymphocytic infiltration. The main function of lymphocytic infiltration acts as a potential anti-tumor mechanism. In this method pathologist and oncologist go for manual tumors detection. By using the methods like Voronoi diagram, Delaunay triangulation and minimum spacing tree in order to determine the significant features from the graphs. The estimated methods that are used here are Hausdorff distance, Cross Validation using SVM classifier, VZ Textron based classifier as in [1].

Using CADx system this method is automated. Here we use region growing algorithm and consequent MRF based refinement to isolate LI from the surrounding BC nuclei, baseline level of Lymphocytes as in [1]. Segmentation of the tumor can also have performed by using Gaussian Markov Random Fields. Here the entire image is assumed such that it is having two classes and it is modeled using GMRF. The encoding for spatial interactions between the pixels, its parameters can be easily estimated using least squares. These methods are suitable for real time applications. The segmentation
section 6 followed by performance comparison for existing method with image.

Fig1: Typical image of tumor

In this paper for the diagnosis of neoplasm we use an algorithm developed by using simple Fuzzy logic and GMRF. The main aim of this work is to expand a robust algorithm for the diagnosis of tumors. Here we use real time segmentation algorithm for this technique. Markov random field helps us to deal with the uncertainties in an image by means of explicitly assign the spatial interaction between the pixels as a probability distribution. The entire is assumed such that it is having two classes and is modeled by using GMRF. GMRF is the extension of MRF that is used for the purpose of encoding spatial interaction between the pixels and easily estimated by using least square. Latfi A. Zadeh was introduced the Fuzzy logic. Fuzzy logic has been applied for many fields from control theory to artificial intelligence as in sec IV.

The rest of the paper is organized as follows. Section 2 gives basic definitions and notations of MRF theory and its properties. Section 3 narrates about GMRF. Section 4 narrated about the fuzzy logic with edge detection. The image model is represented in section 5. The performance comparison for existing method with proposed method are discussed in section 6 followed by conclusion.

II MARKOV RANDOM FIELDS:

Markov random is a graphical model of joint probability distribution P. It consists of undirected graph G = (V, E) in which the pixels V represent the random variables. Let X_s be the set of random variables associated with set of pixels v (X = X_s). Then the edges E encodes conditional independent relations of given disarrange set of pixels.

2.1 Properties of Markov random fields:

2.1.1 Pair wise Markov property: Any two-disconnected pair of random variables is conditionally independent given extra variables. P With respect to a graph G if for any \{s, t\} \in V that are not connected by edge.

\[ X_s \perp X_t \mid X_{V(s, t)} \quad \text{if} \quad \{s, t\} \in V \]

2.1.2 Local Markov property:

P satisfies the local Markov property with respect to G if the conditional distribution of variables given its adjacent is independent of the extra nodes. If for any s \in V

\[ X_s \perp X_{V\backslash{s}} \mid X_{\text{ne}(s)} \quad \text{if} \quad s \in V \]

Where ne(s) is the set of neighbors of s, cl(s) = \{s\} U ne(s) is the closed neighborhood of s.

2.1.3 Global Markov property:

P satisfies the global Markov property with respect to G if for any disarrange vertex subsets A, B, and C, such that C is independent of A and B, the Random variable X_A are conditionally independent of X_B given to X_C.

\[ X_A \perp X_B \mid X_C \quad \text{Where} \quad X_{A\cup{X_s}} \in \{X_s\}_{s} \]

2.2 Clique factorization:

The Markov properties of an arbitrary probability distribution are difficult to found frequently used class of Markov random fields are those that can be factorized according to the cliques of the graph as in [1].

Given a set of random variables \(X = (X_s)_{s \in V}\), let \(P(X=x)\) be the probability of a particular field \(x\) in \(X\). In order to find the probability \(P(X=x)\) of random variable \(X\). If for this joint density can be factorized over the clique of \(G\):
P(X=x) = \prod_{c \in cl(G)} \Phi_c(X_c)

Where x represents a Markov random field with respect to G and cl(G) is the set of cliques of G. The definition is equivalent if minimal cliques are used. The function \Phi_c is called as factor potentials or clique potentials.

If this density is positive by Hamersley-Clifford theorem, if the graph is chordal it is equivalent to Bayesian network.

III. GAUSSIAN MARKOV RANDOM FIELDS:

3.1 Definition:

The Markov property on a spatial lattice includes spatial dependence explicit conditionally, which permits intuitively appealing site-by-site model building. These are also a case, such as in biological network analysis, whereas the Markov property as a deep mathematical significance. Likewise, the model is much important for estimating the efficiency of Markov chain Monte Carlo algorithm. Here we establish a new criterion to fit a GMRF to a given Gaussian field, where the Gaussian field is indicated by its spatial covariance’s.

A gaussian field X on a finite lattice D is a Gaussian random vector X=(X_1, X_2, \ldots, X_n)^T of length |D|=n with mean \mu and precision matrix Q>0. The precision matrix of X is Q=-1. If \pi(X) indicates the density of the variable X, then for a Gaussian field, \pi(X) = N(\mu, E). If its density functions has the form

\pi(X) = (2\pi)^{-n/2} |Q|^{1/2} \exp(-1/2 (x-\mu)^T Q(x-\mu))

And Q_{ij} \neq 0 \iff \{i, j\} \in E \text{ for all } i \neq j.

Gaussian fields are mostly concerned with zero mean, which are characterized by with entries given by pairwise covariances, \{ \text{cov}(X_i, X_j) \}.

Let G = (V, E) be an undirected graph, where V is set of vertices and E is set of edges. In spatial condition V = D, the spatial domain for any site

i \in V, N(i) is the set of neighbors of i assign by those sites j \in V connected to i by an edge in E. let XN(i) indicate the random vector of those Xj, where j \in N.

3.2 Properties of GMRF:

Consider the random vector X indexed by the vertices of an undirected graph G. The Markov property on the graph G= (V, E) state that

If X_i \perp X_j \mid X_{ij} then there is no edge between i and j, \{i, j\} \in V

If X_i \not\perp X_j \mid X_{ij} then there is an edge between i and j.

A finite Markov random field is a random vector that follows the Markov property with respect to graph. As a special case, the GMRFs are particularly appealing since we can get joint distribution in closed form and they denote the precision matrix (as same as covariance matrix).

IV. FUZZY LOGIC:

4.1 Definition of fuzzy logic:

Fuzzy Logic is a mathematical logic that tries to solve the problems by assigning values to the indefinite spectrum of data to arrive at the perfect conclusion. Fuzzy Logic is used to conclude whether a pixel is an edge pixel or not. It starts from fuzzifying the gray values of a pixel into two fuzzy variables, specifically indicated as black and the white. Fuzzy rules are defined to determine the edge pixel in the fuzzified image. Lotfi A. Zadeh was introduced the term “Fuzzy logic” in the year 1965.

This Fuzzy logic edge detection method is used to find the edge pixels by applying the rules to each pixel along with its 8-neighbourhood pixels. By applying the rules, every pixel is designated as “white” and “black” pixel using triangular membership function.

4.2 Fuzzy with edge detection:

Edge detection plays an important role in various applications of image processing such as pattern recognition and image segmentation. Edges are formed from the pixels with derivative values that exceed a predetermined 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 and image tracking. On the contrary, fuzzy logic applies simple if-then rules, which do not require any thresholding or complex gradient based calculations as in [3]

In this, there are a lot of ways to detect edges using fuzzy image processing. The simplest way is to
fuzzify the image. This involves recognizing the membership value of each pixel for a particular set and then applying the fuzzy rules to the fuzzified image to find the edge map. If the information in a database is inexact or incomplete, then the logical use of fuzzy logic becomes practically crucial.

Pixels are indicated as darker or brighter, coming under the region of fuzzification. The darker pixels are placed in the black class, whereas, the brighter ones in the white class. In order to fuzzify the image, the membership of every pixel is found by using the triangular membership function. The membership function values always lie in between [0……1].

4.3 Fuzzy Rules:

Human beings make decisions based on rules. The choice of making the decision is 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 variables. A and B are the values that are determined by fuzzy sets of X and Y respectively. The values may be either black or white. The decision to find whether pixel is an edge pixel or not is made by using the fuzzy rules applied to the 8-neighborhood pixels. The pixels in the 8-neighborhood of a pixel may be black or white as in [2].

V. IMAGE MODEL:

Tumor can be identified by using GMRF but this proposal cannot detect the noisy images. So, to overcome this problem, we develop here a new algorithm that uses edge detection with fuzzy logic along with GMRF property.

In this newly developed algorithm first, we capture an RGB color image of size MxN and convert it into a grayscale image. Then apply the Fuzzy logic. For this, we need the histogram of gray scale image. Based on this, we have to select the fuzzy variables ‘a’ and ‘c’ physically. And then apply the fuzzy rules after that converts the matrix image into grayscale image.

Now GMRF property is to be applied. For each time, we need to take two 3x3 matrices and evaluate the absolute difference between the pixels of the two matrices. If it is equal to 1 then calculate s, otherwise calculate s1. Combining s and s1 calculate new matrix v. 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.

VI. PERFORMANCE MEASUREMENT

To compare the performance of the proposed method with existing method, we add two types of noises for both existing method and proposed method. The two types of noises are 1. Gaussian noise 2. Salt & Pepper noise

After adding these two types of noises we compare the original image with noise added image. Now draw the graph for two noises by note down 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 GMRF and Fuzzy logic method with different Threshold Values. |
Table 2: Comparison of output of GMRF with Fuzzy logic method with Salt & Pepper Noise

<table>
<thead>
<tr>
<th>Original image</th>
<th>Only GMRF Output</th>
<th>GMRF with Fuzzy logic output</th>
<th>Threshold value for fuzzy logic(a,c)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.jpg" alt="Image" /></td>
<td><img src="image2.jpg" alt="Image" /></td>
<td><img src="image3.jpg" alt="Image" /></td>
<td>120,170</td>
</tr>
<tr>
<td><img src="image4.jpg" alt="Image" /></td>
<td><img src="image5.jpg" alt="Image" /></td>
<td><img src="image6.jpg" alt="Image" /></td>
<td>120,170</td>
</tr>
<tr>
<td><img src="image7.jpg" alt="Image" /></td>
<td><img src="image8.jpg" alt="Image" /></td>
<td><img src="image9.jpg" alt="Image" /></td>
<td>240,170</td>
</tr>
<tr>
<td><img src="image10.jpg" alt="Image" /></td>
<td><img src="image11.jpg" alt="Image" /></td>
<td><img src="image12.jpg" alt="Image" /></td>
<td>160,170</td>
</tr>
<tr>
<td><img src="image13.jpg" alt="Image" /></td>
<td><img src="image14.jpg" alt="Image" /></td>
<td><img src="image15.jpg" alt="Image" /></td>
<td>120,170</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Original image</th>
<th>Only GMRF Output</th>
<th>GMRF with Fuzzy logic output</th>
<th>Noise in GMRF o/p</th>
<th>Threshold value for Fuzzy Logic(a,c)</th>
<th>Noise in Fuzzy o/p</th>
</tr>
</thead>
<tbody>
<tr>
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<td><img src="image18.jpg" alt="Image" /></td>
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<td>120,275</td>
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<td><img src="image20.jpg" alt="Image" /></td>
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<td>10.78</td>
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<td><img src="image24.jpg" alt="Image" /></td>
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<td>18.60</td>
</tr>
<tr>
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<td><img src="image27.jpg" alt="Image" /></td>
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<td>160,175</td>
<td>17.12</td>
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<tr>
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<td><img src="image29.jpg" alt="Image" /></td>
<td><img src="image30.jpg" alt="Image" /></td>
<td>65.10</td>
<td>120,175</td>
<td>4.18</td>
</tr>
</tbody>
</table>
Table 3: Comparison of output of GMRF and GMRF with Fuzzy logic Method with Gaussian Noise.

<table>
<thead>
<tr>
<th>Original image</th>
<th>Only GMRF output</th>
<th>GMRF with Fuzzy logic output</th>
<th>Noise in GMRF</th>
<th>Threshold d value for Fuzzy Logic (a,c)</th>
<th>Noise in Fuzzy output</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Original Image" /></td>
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<td>52.24</td>
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<td>4.43</td>
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<td>120,170</td>
<td>10.65</td>
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<td><img src="image7.png" alt="Original Image" /></td>
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<td>48.87</td>
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<td>18.81</td>
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<td><img src="image12.png" alt="GMRF with Fuzzy Logic" /></td>
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<td>12.36</td>
</tr>
<tr>
<td><img src="image13.png" alt="Original Image" /></td>
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<td><img src="image15.png" alt="GMRF with Fuzzy Logic" /></td>
<td>53.42</td>
<td>120,170</td>
<td>2.17</td>
</tr>
</tbody>
</table>

Fig3:- Comparison of GMRF and Fuzzy Logic with salt and pepper noise.

![Comparison Graph](image16.png)

Fig4:- Comparison of GMRF and Fuzzy logic with Gaussian noise.

As shown in above graph we can conclude that the existing method can able to detect the weed up to 10% in Salt & Pepper noised images and up to 1% in Gaussian noised images whereas in the proposed method can able to detect the noise corrupted images by 50% in Salt & Pepper noise and by 10% in Gaussian noised images.

**CONCLUSION:**

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

**REFERENCE:**


