MRI BRAIN IMAGE ANALYSIS FOR TUMOR DETECTION USING OPTIMIZATION TECHNIQUE

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ABSTRACT

Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain. Tumors can directly destroy all healthy brain cells or indirectly damage healthy cells by crowding other parts of the brain and causing inflammation, brain swelling and pressure within the skull. Ant Colony Optimization (ACO) metaheuristic is a recent population-based approach inspired by the behavior of real ants colony and based upon their collective foraging behavior. In ACO, solutions of the problem are constructed within a stochastic iterative process, by adding solution components to partial solutions. Each individual ant constructs a part of the solution using an artificial pheromone, which reflects its experience accumulated while solving the problem, and heuristic information dependent on the problem. In this paper, the proposed technique ACO hybrid with Fuzzy algorithm and Technique are tested from KMCH Hospital Database.

KEYWORDS: Ant Colony Optimization, Fuzzy Algorithm, Metaheuristic, Artificial Pheromone

INTRODUCTION

Tumor is one of the most common brain diseases, so its diagnosis and treatment have a vital importance for more than 400000 persons per year in the world (based on the World Health Organization (WHO) estimates). On the other hand, in recent years, developments in medical imaging techniques allow us to use them in several domains of medicine, for example, computer aided pathologies diagnosis, follow-up of these pathologies, surgical planning, surgical guidance, statistical and time series (longitudinal) analysis. Among all the medical image modalities, Magnetic Resonance Imaging (MRI) is the most frequently used imaging technique in neuroscience and neurosurgery for these applications. MRI creates a 3D image which perfectly visualizes anatomic structures of the brain such as deep structures and tissues of the brain, as well as the pathologies.

Brain tumor is one of the major causes for the increase in Mortality among people. A tumor is an abnormal growth caused by cells reproducing themselves in an uncontrolled manner [10]. In the UK, over 4,200 people are diagnosed with a brain tumor every year (2007 estimates). There are about 200 other types of tumors diagnosed in UK each year. About 16 out of every 1,000 cancers diagnosed in the UK are in the brain (or 1.6%). In India, totally 80,271 people are affected by various types of tumor (2007 estimates). These names depend on where the tumor originated, its pattern of growth, and whether it is cancerous or not. The tumor is divided into two categories: Primary brain tumor and secondary tumor. A primary malignant brain tumor is one that originates in the brain itself although these tumors often shed cancerous cells to other sites in the central nervous system and spread to other parts of the body. Primary brain tumors account for 1.4% of all cancers which occur every year in the United States. These types of tumors are rare and difficult to remove. It has a very heterogeneous response to therapy. A secondary or metastatic brain tumor occurs when cancer cells spread to the brain from a primary cancer in another part of the body. A Metastasis formed from cells that have spread is...
called a secondary tumor, the metastatic tumor are metastasis. The secondary tumor contains cells which are similar to primary tumor.

Although computer-aided MRI brain image has been studied over the last two decades, automated interpretation of segmentation still remains very difficult. Double readings, as carried out, for example, by two radiologists, usually improve the quality of diagnostic findings, thus, greatly reducing the probability of misdiagnosis. On these grounds, adequate computational tools are expected to be helpful to the radiologist. In this paper, meta-heuristic algorithms such as ACO are implemented to extract the suspicious region in the MRI Brain tumor. The textural features can be extracted from the suspicious region to classify them into benign or malign. In this paper, ACO hybrid with Fuzzy is used for Segmentation.

**IMAGE ACQUISITION**

For the treatment of patients with brain tumors, imaging of the brain is often indicated at different stages and usually has a significant role in each of them. The development of intra-operative imaging systems has contributed to improving the course of intracranial neurosurgical procedures. Among these systems, the 0.5T intra-operative magnetic resonance scanner of the Kovai Medical Center and Hospital (KMCH, Signa SP, GE Medical Systems) offers the possibility to acquire 256*256*58(0.86mm, 0.86mm, 2.5 mm) T1 weighted images with the fast spin echo protocol (TR=400,TE=16 ms, FOV=220*220 mm) in 3 minutes and 40 seconds. The quality of every 256*256 slice acquired intra-operatively is fairly similar to images acquired with a 1.5 T conventional scanner, but the major drawback of the intra-operative image is that the slice remains thick (2.5 mm).

Images of a patient obtained by MRI scan is displayed as an array of pixels (a two dimensional unit based on the matrix size and the field of view) and stored in Mat lab 7.0. Here, grayscale or intensity images are displayed of default size 256 x 256. A grayscale image can be specified by giving a large matrix whose entries are numbers between 0 and 255, with 0 corresponding, say, to black, and 255 to white. All images had 1 mm slice thickness with 1×1 mm in plane resolution. In routine, 21 male and female patients were examined. All patients with finding normal for age n=20 were included in this study. The age of patients ranged from 20 to 50 years. All the MRI examinations were performed on a 1.5 T magneto vision scanner (Germany). The brain MR images are stored in the database in JPEG format.

**PREPROCESSING & ENHANCEMENT**

Preprocessing aims at improving the quality of each input image and reducing the computational burden for subsequent analysis steps. Specifically, since skull and other extrameningeal tissues are usually of scarce clinical interest in most MRI studies, they were discarded, along with the background. The MRI image consists of film artifact or labels on
the MRI such as patient name, age and marks. Film artifacts are removed using tracking algorithm. Here, starting from the first row and the first column, the intensity value, greater than that of the threshold value is removed from MRI. The high intensity values of film artifact are removed from MR brain image. During removal of film artifacts, the image consists of salt and pepper noise [11].

**Tracking Algorithm for Removal of Film Artifacts**

1. **Step 1:** Read the MRI image and store it in a two dimensional matrix.
2. **Step 2:** Select the peak threshold value for removing white labels.
3. **Step 3:** Set flag value to 255.
4. **Step 4:** Select pixels whose intensity value is equal to 255.
5. **Step 5:** If the intensity value is 255 then, the flag value is set to zero and thus the labels are removed from MRI.
6. **Step 6:** Otherwise skip to the next pixel.

The image is given to enhancement stage for the high intensity component and the above noise. This stage is used for enhancing the smoothness of the image through piecewise- homogeneous region and reduce the edge blurring effects. This proposed system describes the information of enhancement using median filter for removing high frequency component.

**SEGMENTATION**

Segmentation of images holds an important position in the area of image processing. Computer aided detection of abnormal growth of tissues is primarily motivated by the necessity of achieving maximum possible accuracy. Manual segmentation of these abnormal tissues cannot be compared with modern day’s high speed computing machines which enable us to visually observe the volume and location of unwanted tissues. A well known segmentation problem within MRI is the task of labeling voxels according to their tissue type which include White Matter (WM), Grey Matter (GM), Cerebrospinal Fluid (CSF) and sometimes pathological tissues like tumor etc.

Edge detection is a traditional method for segmentation. Many operators, Roberts gradient, Sobel gradient, Prewitt gradient and Laplacian operator, were published in the literature. Some mathematical morphological operations such as erosion, top-hat transformation and complicated morphological filters and multi-structure elements can also be used. It is good in dealing with geometrically analytic aspects of image analysis problems. Stochastic approaches have also been used to segment calcifications. Stochastic and Bayesian methods have provided a general framework to model images and to
express prior knowledge. Markov Random Field (MRF) model was used to deal with the spatial relations between the labels obtained in an iterative segmentation process. The process assigning the pixel labels iteratively.

**Ant Colony Optimization (ACO)**

Ant Colony Optimization is a population-based approach that was first delivered by Macro Dorigo and co-workers. This approach is based on the real natural behavior of ant colonies [8, 12, 15]. Individual ants are small insects with a very limited capacity of memory and capable of performing simple tasks. The collective behavior of ants provides intelligent solutions such as getting the shortest paths from the nest to their food resources. Ants foraging behavior lay down some quantities of a volatile chemical substance called pheromone, marking their path that it follows. Ants smells this chemical substance and follow the path with a high probability of decision[3, 4, 9]. The probability that an ant chooses a path increases with the number of ants choosing the path at previous times and with the strength of the pheromone concentration laid on it[1, 3, 4, 9].

In this proposed research, the labels that are created from the MRF (Markov Random Field) method and the posterior energy function values for each pixel are stored in a solution matrix. The goal of this approach is to find out the optimum label of the image that minimizes the posterior energy function value. Initially assign the values of the number of iterations as N=15, number of ants as K=20, and initial pheromone value as To.

**Pheromone Initialization**

The initial pheromone value To has been initialized as 0.001 for each ant and a random pixel value is selected from the MRI image. To find out the pixels is been selected or not, use a flag value. Initially this flag value is assigned as 0. If once the pixel has been selected, the flag will be changed to 1. This procedure is followed for all the ants. For each ant a separate column for pheromone and flag values are allocated in the solution matrix.

**Local Phermone Update**

Update the pheromone values for all the randomly selected pixels using the following equation:

\[ T_{\text{new}} = (1-\rho) \times T_{\text{old}} + \rho \times \alpha T_{\text{old}} \]

where \( T_{\text{old}} \) and \( T_{\text{new}} \) are the old and new values of pheromone, \( \alpha \) is equal to \( 1/G_{\text{min}} \) and \( \rho \) is the rate of pheromone evaporation parameter in local update, ranges form \( [0,1] \) i.e., \( 0<\rho<1 \). Calculate the posterior energy function value for all the selected pixels from the ants from the solution matrix. Thus the pheromones are updated globally. This procedure is repeated for all the image pixels. At the final iteration, the Gmin has the optimum label of the image. To further enhance the value, this entire procedure can be repeated for any number of times. In our implementation, we are using 15 numbers of iterations.

**Global Pheromone Update**

Genetic algorithm [6, 7, 14] is used to compare the posterior energy function value for all the randomly selected pixels from each ant, to select the minimum value from the set, which is known as ‘Local Minimum’ (Lmin) or ‘Iterations best’ solution. The subsequent algorithm implements genetic operators to find out the local minimum.

**RESULTS AND ANALYSIS**

The following Table 1 shows the result of image segmentation of PACO. The computation time is one of the metric in the image processing and any other systems. Here, we have calculated the number of tumor cells of different neighborhood pixels of 3×3, 5×5, 7×7, 9×9, 11×11, 15×15 windows.
Table 1: Adaptive Threshold, No of Segmented Pixel, Computation Time and Weight

<table>
<thead>
<tr>
<th>Value/ Neighborhood Pixels</th>
<th>3×3</th>
<th>5×5</th>
<th>7×7</th>
<th>9×9</th>
<th>11×11</th>
<th>15×15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Threshold</td>
<td>188.05</td>
<td>164.09</td>
<td>161.72</td>
<td>150.12</td>
<td>138.15</td>
<td>132.67</td>
</tr>
<tr>
<td>No of segmented cells</td>
<td>765</td>
<td>1894</td>
<td>2260</td>
<td>4050</td>
<td>8299</td>
<td>11524</td>
</tr>
<tr>
<td>Computation Time</td>
<td>40.92</td>
<td>27.65</td>
<td>24.62</td>
<td>24.14</td>
<td>19.27</td>
<td>15.76</td>
</tr>
<tr>
<td>Weight</td>
<td>8</td>
<td>40</td>
<td>50</td>
<td>87</td>
<td>122</td>
<td>154</td>
</tr>
</tbody>
</table>

The following Figure 3 shows the experimental results of the various neighborhood pixels.

![Image of various neighborhood pixels](image)

Figure 3: Result of the Segmented Tumor for Various Neighborhood Pixels

CONCLUSIONS

In this work, the MRI Brain image is segmented using the ACO technique. The ACO search is inspired by the foraging behavior of real ants. Each ant constructs a solution using the pheromone information accumulated by the other ants. In each iteration, local minimum value is selected from the ants’ solution and the pheromones are updated locally. Fuzzy Algorithm is used to find out the local minimum. If this value is less than global minimum, the local minimum is assigned to global minimum. The pheromone of the ant that generates the global minimum is updated. At the final iteration global minimum returns the optimum label for image segmentation. In the above 3×3, 5×5, 7×7, 9×9, 11×11, 15×15 windows are analyzed the ACO with Fuzzy of 3×3 window is chosen based on the high contrast than 5×5, 7×7, 9×9, 11×11, and 15×15.

REFERENCES


