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Hybrid Markov Random Field with Parallel Ant Colony Optimization and Fuzzy C Means for MRI Brain Image segmentation

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Abstract

In this paper, a novel approach to MRI Brain Image segmentation based on the Hybrid Parallel Ant Colony Optimization (HPACO) with Fuzzy C-Means (FCM) Algorithm have been used to find out the optimum label that minimizes the Maximizing a Posterior (MAP) estimate to segment the image. There are M colonies, M-1 colonies treated as slaves and one colony for master. Each colonies visit all the pixels with out revisit. Initially, initialize the pheromone value for all the colonies. Posterior energy values or fitness values are computed by Markov Random Field. 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 threshold value for select the initial clustering the FCM implementation in the brain Magnetic Resonance Image (MRI) segmentation.

Keywords: MRI Brain Image segmentation, Hybrid Parallel Ant Colony Optimization, FCM Algorithm

Introduction

MRI segmentation has been proposed for a number of clinical investigations of varying complexity. In the clinical context, medical image processing is generally equated to radiology or "clinical imaging" and the medical practitioner responsible for interpreting (and sometimes acquiring) the image is a radiologist. Diagnostic radiography designates the technical aspects of medical imaging and in particular the acquisition of medical images. The radiographer is usually responsible for acquiring medical images of diagnostic quality, although some radiological interventions are performed by radiologists [1, 2],

The abnormal growth of cell within the brain or inside the skull can be cancerous or non-cancerous. Tumor is a type of cancer. Cancer begins in cells, the building blocks that make up tissues. Tissues make up the organs of the body. Normally, cells grow and divide to form new cells as the body needs them. When cells grow old, they die, and new cells take their place. Sometimes this orderly process goes wrong.

Some types of cancer only spread to the brain infrequently, such as colon cancer, or very rarely, such as prostate cancer. Brain tumors can directly destroy brain cells, or they may indirectly damage cells by producing inflammation, compressing other parts of the brain as the tumor grows, inducing brain swelling, and cause increased pressure within the skull.

Existing Methods

The Segmentation of an image entails the division or separation of the image into regions of similar attribute. The ultimate aim in a large number of image processing applications is to extract important features from the image data, from which a description, interpretation, or understanding of the scene can be provided by the machine.

The segmentation of brain tumor from Magnetic Resonance Image (MRI) is an important but time-consuming task performed by medical experts. The accurate segmentation of MRI image into different tissue classes, especially Grey Matter (GM), White Matter (WM) and Cerebrospinal Fluid (CSF). In brief, segmentation determines the Regions of Interest (ROIs) in an image. This does not mean that the segment or will try to determine the type of the region, but merely determine the pixels in an image which belong to the same item.

The digital image processing community has developed several segmentation methods, four of the most common methods are: 1) amplitude thresholding, 2) texture segmentation, 3) template matching and 4) region-growing segmentation. It is very important for detecting tumors, edema and necrotic tissues. These types of algorithms are used dividing the brain images into three categories (a) Pixel Based, (b) Region or Texture Based and (c) Structural Based. Several authors suggested various algorithms for segmentation

Proposed Method

Image Acquisition

To Access the real medical images like MRI, PET (Positron Emission Tomography) or CT (Computer Tomography) scan and to take up a research is a very complex because of privacy issues and heavy technical hurdles. The purpose of this study is to compare Automatic Brain Tumor Detection methods through MRI Brain Images. MRI Images were transformed to a Linux Network through LAN (Local Area

Network) Kovai Medical Center Hospital (KMCH) India. All images had 1 mm slice thickness with 1×1 mm in plane resolution.

The development of intra-operative imaging systems has contributed to improvement of 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 1.5T Conventional Scanner, but the major drawback of intra-operative image is that slice remains thick (2.5 mm).

An image 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) are stored. Images are three types (a) Binary Images (b) Gray Scale Image (c) Color Image. In this paper, Consider grayscale or Intensity Images to display an image with default size of 256 x 256. The following figure (3.1) displays a MRI Brain Image. A grayscale Image can be specified by giving a large matrix whose entries are numbers between 0 and 255, with 0 to black and 255 to white.

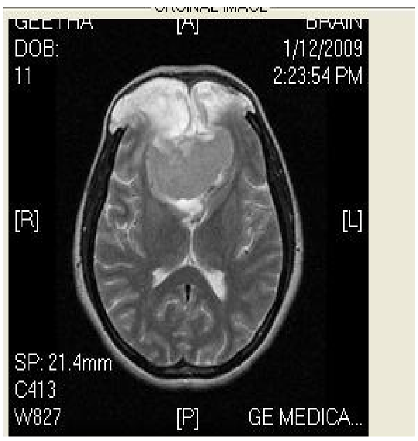

Figure 1: Image Acquit ion.

Preprocessing and enhancement

This Paper highlights the Pre-Processing and Enhancement of the proposed method has been used to remove the Film Artifacts using Tracking Algorithm. The MRI Image is given to Enhancement stage for removing high frequency components. There are three types of filters such as Median Filter, Weighted Median Filter and Adaptive Filter are used to remove high frequency components from MRI Brain Image.

The Computational result is used to enhance the Image and the performance of the system was investigated. The result shows that Weighted Median Filter is better compared with other filtering techniques. The merit of using Weighted Median Filter, it can remove the noise without disturbing the edges.

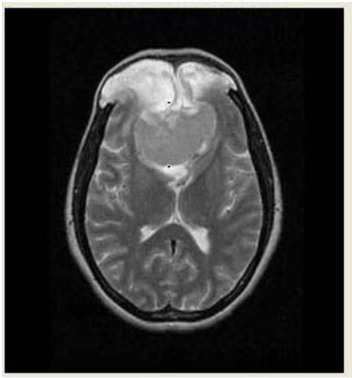

Figure 2: Pre Processed Image.

Table I: Comparative Study of ASNR and PSNR.

S.no	Method	ASNR	PSNR
1	PreProcessing and Enhancement[karnan et. Al, 2005]	0.92	0.94
3	Tracking algorithm [Logeswari et. Al., 2009]	0.92	0.946
4	Proposed method	0.93	0.951

Segmentation

The Segmentation of Brain Tumor from Magnetic Resonance Images is an important but time-consuming task performed by medical experts. The digital Image processing community has developed several segmentation methods. Four of the most common methods are: (a) Amplitude Thresholding, (b) Texture Segmentation, (c) Template Matching and (d) Region-Growing Segmentation. It is very important for detecting Tumors, edema and necrotic tissues. These types of Algorithms are used for dividing the Brain Images into three categories (a) Pixel Based (b) Region or Texture Based (c) Structural Based. Several authors suggested various Algorithms for Segmentation. FCM Algorithm is one of the popular Fuzzy Clustering algorithms which are classified as constrained Soft Clustering algorithm]. A Soft Clustering Algorithm finds a soft partition of a given data set by which an element in the data set may partially belong to multiple clusters [3.4].

There are M colonies, M-1 colonies treated as slaves and one colony for master. Each colonies visit all the pixels with out revisit. Initially, initialize the pheromone value for all the colonies. Posterior energy values or fitness values are computed by Markov Random Field[11]. Finally each colonies yield global optimum value and also master colony system yield global optimum value. There fore M-1 slave colonies produced M-1 optimum value. These values are compared and then the highest global optimum value again compares to the master global value. If the slave colonies values are less than the master value then the value is discarded other wise the values are interchanged or swapped. This optimum value treated as a adaptive threshold value. The optimal value of HPACO is used to select the initial cluster point. [5.6.7.8.9.10].

Steps for program in PACO
Step 1: to find out the unique labels
2: to find out the posterior values
3: initliasition for each colonies.
{
4: slave colonies systems
{ colony 1, colony 2…. Colony M-1

Algorithm of colony 1
M_{ij} ← Original Image
for each pixel in M_{ij}
G ← kernel of the border pixel of size 3×3 from M
U ← fitness value; the posterior energy U (x) is calculated.
$U (x) =\{\sum[(y-\mu)^2 / (2 * \sigma^2)] +\sum \log(\sigma) + \sum V(x)\}$
end
N ← 50; K← 10; T_0← 0.001; ρ ← 0.9
S ← {U(x),T_0, flag} flag column mentions whether the pixels is selected by the ant or not.
Store the energy function values in S. Initialize all the pheromone values with T_0=0.001.
repeat for N times
for each pixel in M_{ij}
for each ant
g_i ← a random kernel for each ant, which is not selected previously.
$T_{new} \leftarrow (1-\rho) * T_{old} + \rho * T_0$ for g_i
end
Lmax ← max(U_i(x))
if (Lmax < Gmax) then Gmax = Lmax
g ← Select the ant, whose solution is equal to local maximum
$T_{new} \leftarrow (1 - \alpha) * T_{old} + \alpha * \Delta T_{old}$, only for g
End
end
Similarly this algorithm is used to M-1 slave ant colonies and also master ant colonies system
}
Step5: the final highest global value derived from slave ant colony system.
6: master colony system
7:The master colony yield global optimum value
8 : compare to 5 and 7, the highest global optimum value treated as a optimum threshold value.
} The Gmin has the optimum label which minimizes the posterior energy function.

Step 1: The optimal value HPACO is used to select the initial cluster point.
FCM- ACO Algorithm is the following:

Step 2: Calculate the cluster centers.
C = (N/2)1/2
Step 3: Compute the Euclidean distances
$D_{ij} = CC_p – Cn$
Step 4: Update the partition matrix

$$U_{ij} = \frac{1}{\sum_{k=1}^{c}\left(\frac{d_{ij}}{d_{kj}}\right)^{2/(m-1)}}$$

(Repeat the step 4)
Until Max[$|U_{ij}(k+1)-U_{ij}k|$] <€ is satisfied
Step 5: Calculate the average clustering points.

$$C_i = \sum_{i=1}^{c} J_i = \sum_{i=1}^{c}\sum_{j=1}^{n} U_{ij}{}^{n} d_{ij}{}^{2}$$

Step 6: Compute the adaptive threshold
Adaptive threshold =max (Adaptive threshold, c_i) i=1...n

In the MRI image, the pixels having lower intensity values than the adaptive threshold value are changed to zero. The entire procedure is repeated for any number of times to obtain the more approximated value [12.13.14.15].

Conclusion

Hundred and twenty brain image obtained from the KMCH hospital database is used to design the proposed diagnosing system. In Preprocessing and Enhancement, The tracking algorithm is proposed to remove film artifacts such as labels and X-ray marks from the MRI Image to increase the reliability of the segmentation. The three filtering technique such as Median Filter, Weighted Median Filter and Adaptive Filter is applied to remove the high frequency components in the MRI image. The result is compared in that the advantage of using Weighted Median Filter removes the noise without disturbing the edges boundaries etc., and the performance evaluation is measured.

Segmentation is the second stage where Optimization forms an important part of our day to day life. Many scientific, social, economic and engineering problems have parameter that can be adjusted to produce a more desirable outcome. Over the years, numerous techniques have been developed to solve such optimization. This study investigates the most effective optimization method, known as Hybrid Parallel Ant Colony Optimization (HPACO) is introduced in the field of Medical Image Processing.

The suspicious region is segmented using algorithm HPACO. New CAD System is developed for verification and comparison of brain tumor detection algorithm. HPACO automatically determine the optimal threshold value of given image to select the initial cluster point then the clustering algorithm Fuzzy C Means automatically calculates the adaptive threshold for the brain tumor segmentation. The results are compared with the existing approaches. Computational result indicates that the Hybrid Parallel Ant Colony Optimization algorithm improves the performances of the segmentation and can find the optimum solution faster than the other two methods.

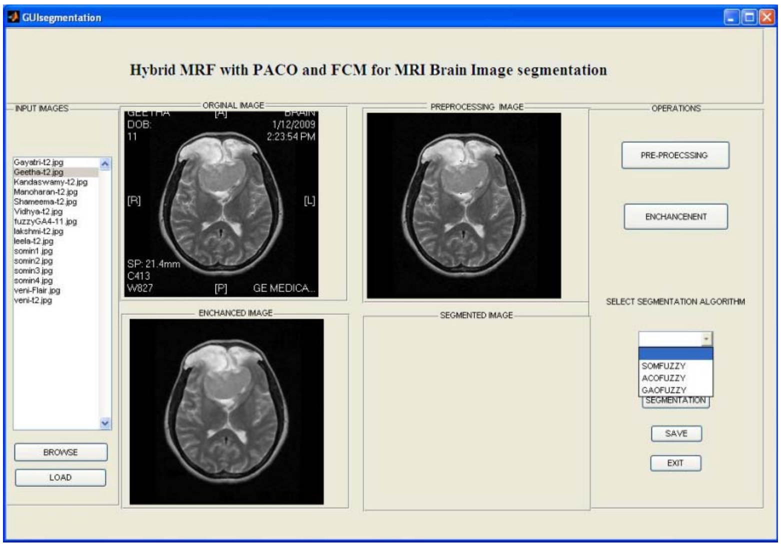

Figure 3: Snap shoot for preprocessing stage.

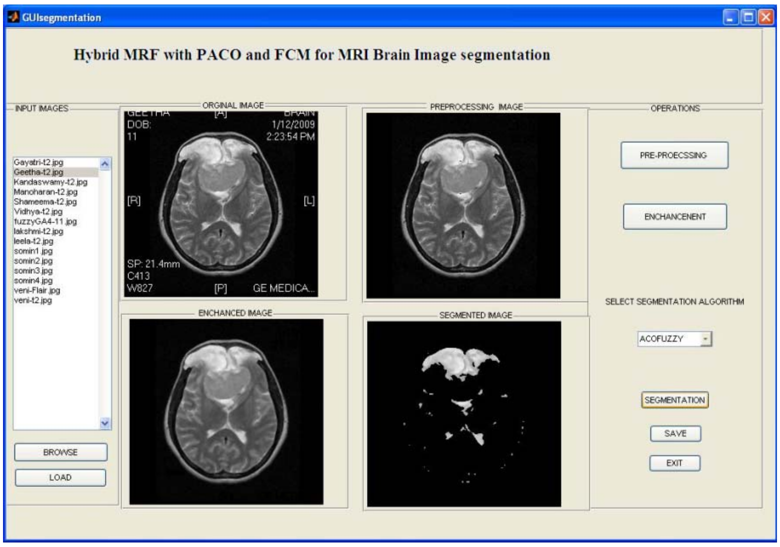

Figure 4: Snap shoot for Hybrid MRF with PACO and FCM for MRI Brain Image segmentation.

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