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RESEARCH ARTICLE

BRAIN TISSUE SEGMENTATION FROM MAGNETIC RESONANCE IMAGE USING PARTICLE SWARM OPTIMIZATION ALGORITHM

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Abstract- Magnetic Resonance Imaging is one of the best technologies currently being used for diagnosing brain tumor. Brain tumor is diagnosed at advanced stages with the help of the MRI image. Segmentation is an important process to extract suspicious region from complex medical images. Intelligent system is designed to diagnose brain tumor through MRI using image processing algorithms such as Particle Swarm Optimization. The proposed system is having three phases. In the first phase, preprocessing is performed to remove the film artifacts and unwanted skull portions in brain MRI image. In the second phase, enhancement is performed to remove noise in brain MRI image. In the third phase, Particle Swarm Optimization is implemented for segmenting tissues such as WM (White Matter), GM (Grey Matter) and CSF (Cerebrospinal Fluid) in brain MRI image. The segmented brain MRI helps the radiologists in detection of brain abnormalities and tumor. The algorithm is tested for 50 real patient's brain MRI image.

Keywords – Magnetic Resonance Imaging; Preprocessing; Enhancement; Segmentation; Particle Swarm Optimization

I. INTRODUCTION

Magnetic resonance imaging (MRI) is a noninvasive medical test that helps physicians diagnose and treat medical conditions. MR imaging uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. It does not use ionizing radiation (x-rays) and MRI provides detailed pictures of brain and nerve tissues in multiple planes without obstruction by overlying bones. Brain MRI is the procedure of choice for most brain disorders. It provides clear images of the brainstem and posterior brain, which are difficult to view on a CT scan[1].

Segmentation is the process of partitioning a digital image into multiple segments. Segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images. Medical image segmentation is a key task in many medical applications such as surgical planning, post-surgical assessment, abnormality detection and so on. Brain image segmentation is quite complicated and challenging but its accurate segmentation is very important for detecting tumors and tissues.

There are many conventional Methods of MRI segmentation that uses image processing techniques such as region growing, edge detection, and histogram Equalization, etc. The problem with all these methods is that, they need human interaction for accurate and reliable segmentation. In this paper, Particle Swarm Optimization algorithm is proposed for automatic brain tissue segmentation.

II. PROPOSED SYSTEM

The proposed system has three phase**s.** The three phases are Preprocessing, Enhancement and Segmentation. The Block diagram for proposed system is shown in Fig3.

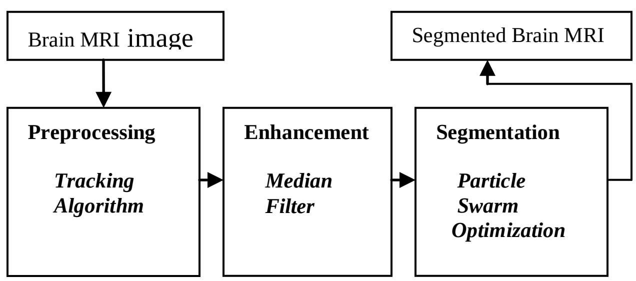


Fig1. Block diagram for proposed system.

2.1 Preprocessing

Preprocessing images commonly involves removing low-frequency background noise, normalizing the intensity of the individual particles images, removing reflections, and masking portions of images. Image preprocessing is the technique of enhancing data images prior to computational processing. The procedure done before processing by correcting image from different errors is preprocessing. This has to be done before image enhancement. Pre-processing methods use a small neighborhood of a pixel in an input image to get a new brightness value in the output image. Such pre-processing operations are also called filtration.

Tracking Algorithm

Pre-Processing involves the process of removing the film artifacts of MRI brain image. The film artifacts include the Patient's Name, age and other details. These film artifacts are removed by using tracking algorithm. This algorithm is as follows:

1. Read the MRI image and store it in a two dimensional matrix.
2. Select the peak threshold value for removing white labels
3. Set flag value to 255.

4. Select pixels whose intensity value is equal to 255.
5. If the intensity value is 255 then, the flag value is set to zero and thus the labels are removed from the MRI
6. Otherwise skip to the next pixel.

2.2 Enhancement

Image enhancement is a processing of images to bring out specific features of an image. It highlights certain characteristics of an image. Used to process image so that the result is more suitable than the original image for a specific application.

Median Filter

The median filter is a sliding-window spatial filter. It replaces the value of the center pixel with the median of the intensity values in the neighborhood of that pixel. Median filtering is a nonlinear operation often used in image processing to reduce salt and pepper noise. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges. For every pixel, a 3x3 neighborhood with the pixel as center is considered. In median filtering, the value of the pixel is replaced by the median of the pixel values in the 3x3 neighborhood.

F=Medfilt2(F, [matrix range])

2.3 Segmentation

Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image.

Particle Swarm Optimization Algorithm

Particle swarm optimization (PSO) is one of the modern heuristic algorithms that can be applied to non linear and non continuous optimization problems. It is a population-based stochastic optimization technique for continuous nonlinear functions. PSO learned from the scenario and used it to solve the optimization problems. Particle Swarm Optimization is an optimization technique which provides an evolutionary based search. This search algorithm was introduced by Dr. Russ Eberhart and Dr. James Kennedy in 1995. The term PSO refers to a relatively new family of algorithms that may be used to find optimal or near to optimal solutions to numerical and qualitative problems.

The particle swarm concept was originated as a simulation of simplified social system. The original intent was to graphically simulate the choreography of bird of a bird block or fish school. However, it was found that particle swarm model can be used as an optimizer. PSO is initialized with a group of random particles (solutions) and then searches for optima by updating generations. In every iteration, each particle is updated by following two "best" values. The first one is the best solution (fitness) it has achieved so far. (The fitness value is also stored.) This value is called pbest. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population. This best value is a global best and called gbest. When a particle takes part of the population as its topological neighbors, the best value is a local best and is called lbest[2].

Step 1: Load the image the size is 256x256 (each element corresponds to a gray value). Between 0 to 256 and their classes are determined.
Step 2: Divide the image to 3x3(or) 5x5(or) 7 x7 labels etc.
Step 3: Initialize all particles inside the labels.
Step 4: Calculate the fitness value for all pixels in the label.
Step 5: Select the best optimum (pBest) value for the label.

If (fitness value<best fitness value (pBest) in history
update current value =new pBest
else current value= fitness value

After selection of current value elements are put in their respective labels.
Step 6: Repeat Step 4 and 5 for all elements until end of the label.
Step 7: Choose the particle with the best fitness value of all the particles as the gBest.

Step 8: Calculate particle velocity for each particle.

v [cp] = v[cp] + c1 * rand() * (pbest[p] - present[p]) + c2 * rand() * (gbest[p] - present[])

v [cp] = current particle velocity
pbest[cp] =best fitness value
gbest[] = fitness values of the all particles
rand()= random number between (0,1)
c1, c2 are learning factors.
Usually c1 = c2 = 2.

Step 9: Update particle position for each particle according the given solution.

present[] = persent[] + v[]
persent[] is the current particle

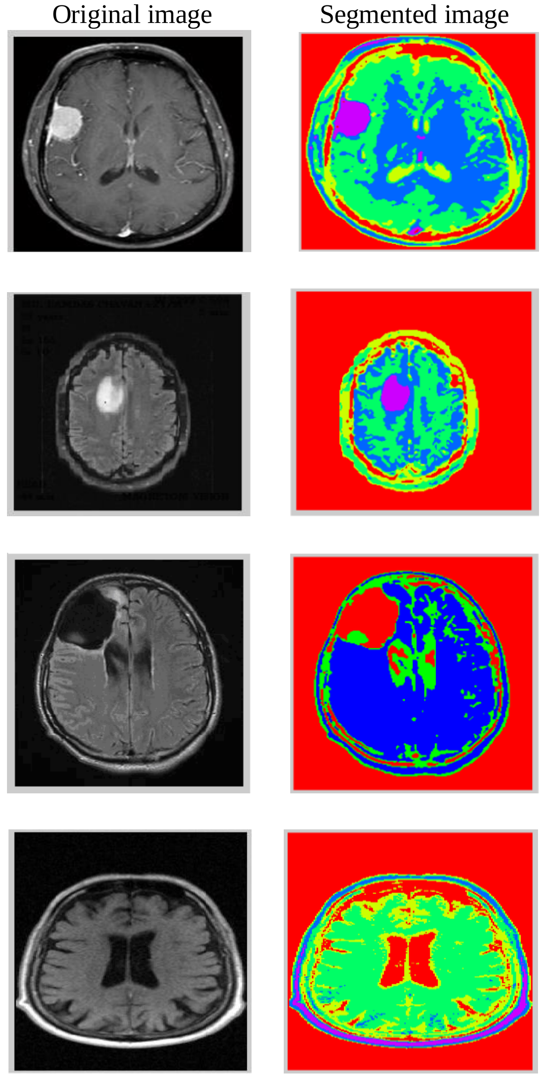
After updation of velocity and position of each particle.

Step 10: Go to step 2 for further labels.

III. EXPERIMENTAL RESULTS

Particle Swarm Optimization algorithm is used for brain tissue segmentation. It segments the tissues like white matter, grey matter and CSF from MRI brain image. The segmented result for MRI brain images are given in Fig2.

Original image Segmented image



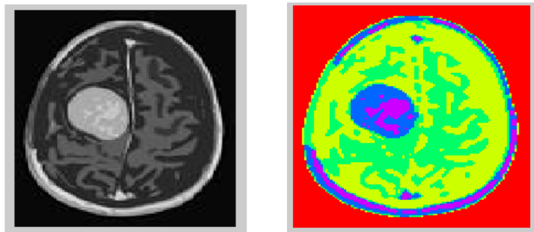


Fig2. The segmented result of PSO for MRI brain images.

III. CONCLUSION

The intelligent system is designed to segment brain tissue through MRI using Particle Swarm Optimization algorithm. Initially the preprocessing stage was finished through tracking algorithm. Next the preprocessed image is enhanced using median filter. Then the enhanced image is segmented using PSO algorithm to segment brain tissues such as white matter, gray matter and CSF in brain MRI image. The algorithm is tested for 50 brain MRI images.

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