An Approach to Brain Tumor Segmentation and Severity Analysis using Particle Swarm Optimization

Divyanshu Sinha, Aditya Tandon, Phong Thanh Nguyen, S. Rama Sree

Abstract: - Medical image processing is one of the most challenging and emerging filed. Processing of medical image is one of the important tasks for the diagnosis of brain tumor. Image segmentation is required for detection of brain tumors, which is a quite complicated job if performed automatically. In recent time, scientists from various fields including medical, mathematical and computer science have collaborated together to find out a better understanding of the disease and devise more cost effective treatments. Due to advancements in the field of science and technology ,we have innumerous methods for image segmentation which are used for the detection of brain tumor and to clearly recognize it from MRI imagery. Various methods and algorithms have been implemented for segmenting MRI imagery. In the following paper, we have used Particle Swarm Optimization (PSO) technique to recognize brain tumor by looking at an MRI image. For severity analysis of brain tumor, machine learning algorithm is used.

Index terms: Magnetic Resonance Imaging (MRI), Brain Tumor, Particle swarm optimization, Machine Learning

I.INTRODUCTION

Brain tumor is defined as an abnormal growth of the cell tissues in the brain that hampers the proper functioning of the brain.Tumors are defined on the basis of the place where the tumor cells started multiplying, and also if they are cancerous or not.Cancer causing tumors are known as malignant and the ones which are not cancerous are known as benign tumor.If they are left unnoticed the tumors can grow and damage normal brain tissues, which could eventually result in death. They form in different areas, develop from different cell types, and may have different treatment options.

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The less harmful type of brain tumor is called a benign brain tumor,and they originate from cells within or surrounding the brain,and they do not contain cancer cells.Malignant brain tumors contain cancer cells and do not have clear borders. They are considered to be life-threatening because they grow rapidly and invade surrounding brain tissue.Diagnosis of a brain tumor is done by a neurologic exam, CT scan or magnetic resonance imaging.

A.Background

There are numerous algorithms which were proposed recently for a major breakthrough for brain tumors but those methods are still not much in medical practice because they have issues in giving the correct accuracy as desired and also there are corpulent concerns. Artificial intelligence techniques such as the DIP, recognitions of patterns and the fuzzy logic systems are very much useful and effective in the field of image-processing. The main aim of our paper is to formulate an effective way for the segmentation of brain MRI images and thereafter performing the severity analysis of the brain tumor**.**

B.Statement of Problem

The drawbacks of the related works was that they were able segment the MRI brain image but the tumor was not detected. Besides the segmentation accuracy was very low thereby increasing the time required for the computation processes. The algorithms used in the segmentation are the k-means, Fuzzy C-Means and ACO techniques. So, to increase the accuracy and the time requirement we are using PSO for brain tumor detection and thereafter the severity analysis is performed.

C.Research Objectives

The main objectives of the research are:

- Brain tumor segmentation using Particle swarm optimization
- Severity analysis after brain tumor segmentation

D.Image Acquisition

Due to various unseen factors, collection of real time MRI dataset is not easy. Practical MRI data is obtained from Annapurna Neuro Hospital, and Jeebant Advanced MRI Kathmandu Pvt.Ltd and standard MRI data is obtained fromhttp://www.medinfo.cs.ucy.ac.cy for real time segmentation and severity analysis of brain tumor.

E.Segmentation

This process is considered as the foremost and the most crucial step for analyzing the image.Its main aim is to collect the image particulars from the provided segmented images.This method is widely used for treating the patients by assisting in computer based surgery. The three main types of segmentation are thresh holding, edge base and region base.The process of clustering comes under region split and merge methods of segmentation.

F.Clustering

Clustering is the process of recognizing similar groups of data in a given dataset**.** It can also be understood as the method of partitioning the data points into various groups, wherein data points which are similar to each other are grouped together rather than being grouped with dissimilar data points.The clustering technique is further classified as the K means, Fuzzy c means etc.

II. PARTICLE SWARM OPTIMIZATION

PSO was originally conceived as a representation of organisms in a bird flow or fish school. Later it was simplified and was used for solving optimisation problems.PSO uses a bunch of particles called the swarm. These particles are allowed to move around & explore the search-space.These particles move in a direction which is guided by —

1. Inertia
2. Cognitive Force
3. Social Force

Essentially the particles collectively communicate with each other to converge faster. The swarm doesn't fully explore the search space but potentially finds a better solution. Interestingly the overall direction of the swarm movement can be changed at any point of time when a particle's individual best is better than the swarm best. This allows a lot of *disorder* and more chances of getting close to the global minima of the cost function, Unlike Gradient Descent there is *no need for the cost function to be differentiable*. It is a straightforward implementation in Python to simulate these swarm particles. Surprisingly you do not need a lot of mathematics. Its simply determining three different velocities and compute the fitness of the particle. And we iterate over as much we want. The global best or the swarm best will the optimum value. Each particle describes a set of parameter values and a initial velocity (vector). And we compute the fitness by just plugging in those values in the cost function. That will give us the fitness of the particle

III. RESEARCH AND METHODOLOGY

A.Experiment and Process Flow

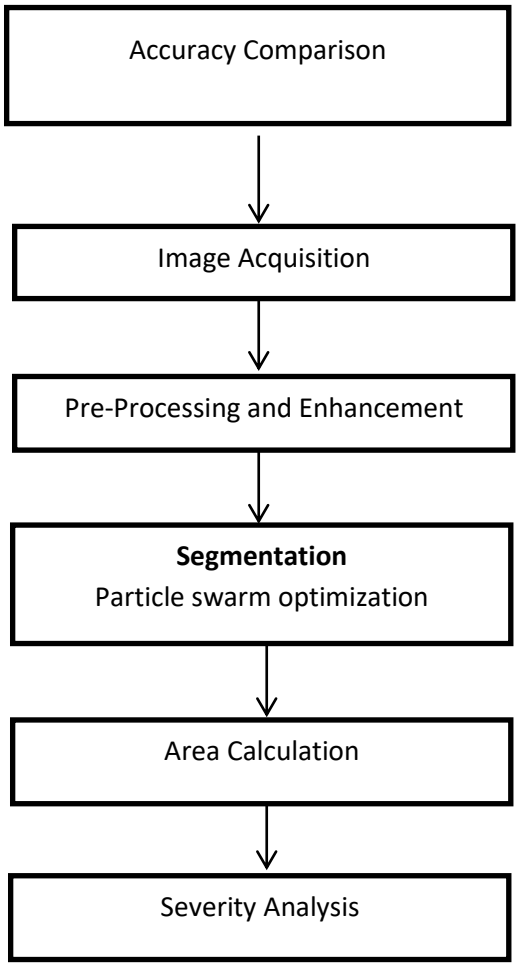

Fig 1: ProposedApproach for Brain Tumor Segmentation and Severity Analysis

B.Image Acquisition

In this phase image is read from the dataset which consist of .tif images. This .tif image is converted into some other format such as .jpg,.bmp or .png using the image format conversion menu.

C.Image Preprocessing

The image preprocessing involve following steps:

1. Gray scale Conversion :In this stage the RBG image is converted into gray scale image.

2. Resize:In this step Gray scale image resized to special size 200*200

3. Noise Removal : To remove the noise from the gray scale converted image I have used median filter 3×3

D.Algorithm

Say, for example, that the problem was to find the minimal values of X and Y for the equation (X*X)-(Y*Y) where X and Y are integers in the range 0 to 10. The algorithm will follow the following execution path

1. Initialize the particles with random values of X and Y in the range 0-10

2. Determine the fitness of the particle by evaluating the equation with the present values of X and Y.

3. Update each particle's position based on its personal best and the global best fitness values.

4. Either, terminate on a preset fitness value or the number of iterations of steps 2 and 3, or else repeat steps 2 and 3.

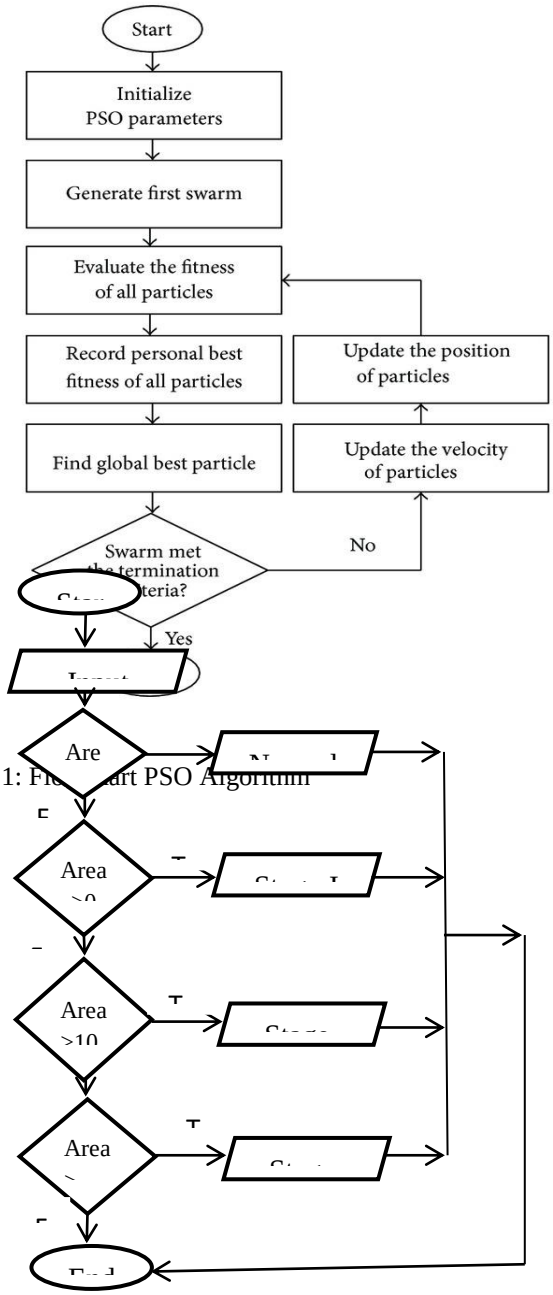

Fig 1: Flow Chart PSO Algorithm

Fig 3. Severity Analysis of Brain Tumor

E. Severity Analysis

a)Flow Chart

b)Algorithm

After the segmentation for MRI Brain Image, the area of the detected tumor is used for the analysis of the severity level. The severity level of the tumor is analyzed as per the following algorithm [6].

1. Start
2. Read area of tumor detected
3. if area==0 then

   Normal Brain
4. else if area>0 and area<10 then

   Severity Level-I (Stage-I)

   else if area>=10 and area<15 then

   Severity Level-II(Stage-II)

   Else if area>15 then

   Severity Level-III (stage-III)
5. End

IV.RESULT AND DISCUSSION

I have used two types of dataset for the purpose of analysis as practical and standard dataset.

I have collected the practical dataset from the Annapurna Neuro Hospital and Jeebanta advanced MRI Imaging for this research and standard dataset from www.medinfo.cs.ucy.ac.cy. The total number of standard and practical MRI Images of Brain is 75. Out of 75 standard dataset MRI Brain Images, 62 Abnormal MRI Brain images are abnormal images and 13 images are Normal MRI Brain Images. Similarly, Out of 75 practical dataset MRI Brain Images, 56 Abnormal MRI Brain images are abnormal images and 19 images are Normal MRI Brain Images

MRI Image dataset of consist of MRI images of different persons and are used for performing the experiments and evaluated the value of PSNR, MSE, and Area of the images after clustering for parametric analysis. The images of databases are as shown in below which consist of eight images considered out of one hundred and fifty images. The study mainly focuses on the MRI image segmentation for the detection of tumor and its area calculation. I have tested the system for both normal and brain tumor image.

Table 1 Standard and Practical MRI image Dataset

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Standard MRI mage Dataset

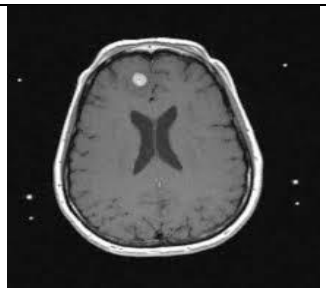

Figure 4:- img3B.jpg

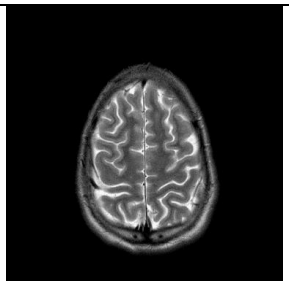

Figure 5:- img019.jpg

Figure 6:- img2PM.jpg

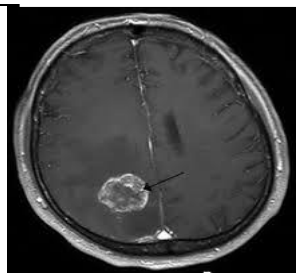

Figure 7:- img02B.jpg

Practical MRI Image Dataset

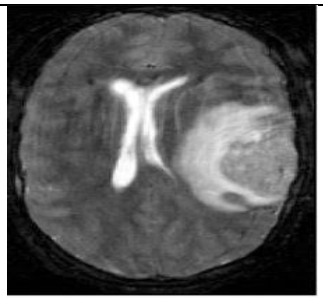

Figure 8:- imgPAN0.jpg

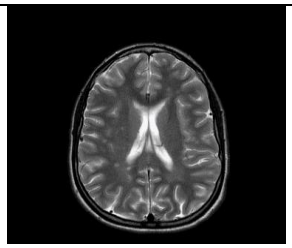

Figure 9:- img014.jpg

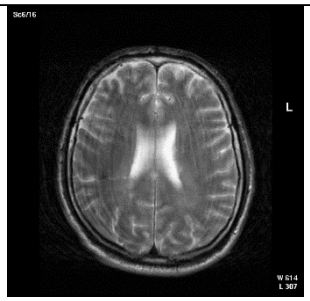

Figure 10:- imgPAN4.jpg

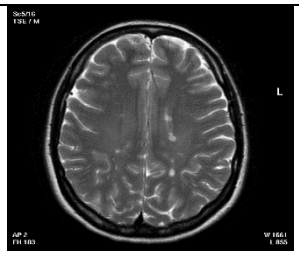

Figure 11:- imgPN1.jpg

V.CONCLUSION

WE have used two types of dataset for the purpose of analysis as practical and standard dataset. We have collected the practical dataset from the Annapurna Neuro Hospital and Jeebanta advanced MRI Imaging for this research and standard dataset from www.medinfo.cs.ucy.ac.cy. The total number of standard and practical MRI Images of Brain is 75. Out of 75 standard dataset MRI Brain Images, 62 Abnormal MRI Brain images are abnormal images and 13 images are Normal MRI Brain Images. Similarly, Out of 75 practical dataset MRI Brain Images, 56 Abnormal MRI Brain images are abnormal images and 19 images are Normal MRI Brain Images. MRI Image dataset consist of MRI images of different persons and are used for performing the experiments and evaluated the value of PSNR, MSE, and Area of the images after clustering for parametric analysis. The images of databases are as shown in below which consist of eight images considered out of one hundred and fifty images. The study mainly focuses on the MRI image segmentation for the detection of tumor and its area calculation. We have tested the system for both normal and brain tumor image.

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