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# Machine Learning Approach improves the Quality of the MRI Images in Tumor Detection and Diagnosis: A PSO based Cluster Analysis

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***Abstract*—Segmentation is the most important and basic technique of image processing which is used for the extraction of suspicious region from the given image. Brain tumor is diagnosed at advanced stages with help of the MRI images. This research aims to quantify the brain tumor loss in MRI human Head Scans by using a computational method. This method proposes Particle Swarm Optimization (PSO) for finding the centroid value to segment the brain tissue. The segmented brain MRI helps the radiologist in detecting brain abnormalities and tumor.**

***Keywords—Magnetic Resonance Imaging, PSO, Clustering, Morphological Operation, Brain Tumor Segmentation***

## I. Introduction

The Human brain is a complex organ.Normally brain cells won't divide after the complete brain development, under certain conditions brain cells were induced to divide, this ends with primary brain tumor. The frequent monitoring of the tumor tissue helps to grade the abnormality, tumor assessment and therapy [1]. For this process, the physicians require imaging technique.

Due to its excellent spatial resolution. Magnetic Resonance Imaging (MRI) images are clear and more accurate. It plays critical role in evaluating the size of tumor and pathology. The manual assessment of tumor tissues from numerous slices of a patient is a tedious task and it takes a toll on the physicians. This condition has pare way for the emergence of an automatic computerized method for tumor extraction. This method can potentially reduce the time taken by the physicians for diagnosis. Recently, machine learning and clustering techniques are used as efficient models for brain image segmentation [2]. The machine learning techniques demand several learning rules, a reasonable amount of training and a competent knowledge in testing data. Sometimes, the training data are not suitable for the unknown dataset. In general, segmentation techniques include the following classifications which are includes: Histogram based method [3], Threshold based method [4], Hybrid method [5], Edge based method [6], Region based method, Cluster based method and Classification based method [7].

Saini et al.,[8] proposed an approach for image segmentation using mathematical morphology. They found the density of cluster for detecting tumor in MRI images. Otsu's method and optimal global thresholding were used for image segmentation. Pre-processing was applied for segmentation followed by wavelet which helps doctors in medical imaging and in the extraction of tumor. They found different types of tissues in image and separated abnormal tissue from normal tissue in these algorithms.

Manorama et al.,[9] had used watershed segmentation with the help of gray scale image on MRI images followed by thresholding and morphological operator for detecting tumor.

Color-based segmentation method was developed by Ming-Ni et al.,[10] using algorithm of k-means clustering technique and histogram clustering methods for tracking tumor object in MRI brain images. The formula employed in this color-based segmentation algorithm with k-means was the conversion of a given gray-level MR image into a color space image facilitates the segregationof the position of tumor objects from other items of an MR images.

Pushpa Rani et al.,[11] developed medical image segmentation detection. In developed countries, many lost their lives to brain tumor due to inaccurate detection. Usages of computer technologies nowadays have become inevitable in medicaldiagnoses especially cancer-related researches pertaining to thebrain, breast, and liver. Various classification methods are used in classifyingtumors in MRI. The Statistical, Intensity, Symmetry, Texturefeatures etc., utilize a gray values of tumors are included for classify the tumor. However, the gray values ofMRI might be slightly varies with the over–enhancement or in the presence of noise [12].The classification techniques are used mainly for prospecting theMR image and for extracting some statistical or texture from the medical image to learn from how interestingly discern medical images eventually develop high performance computer systems[13][14].

A fully automatic method for the detection of brain tumor was developed by Aastha Sehgal et al.,[15]. Itcomprises of a five-stage process that include Image acquisition, Pre-processing, Segmentation, Tumor extraction and evaluation. Extraction of Tumors is carried out by bringing into consideration the following criteria: Area and

Circularityby comparison with manually segmented growth truth which helps to check the validity of the results.

Automatic Brain Tumor Segmentation (ABTS) concept was introduced by Idanis Diaz et al.,[16].The author had presented the segmentation of different constituents parts of the tumor. This strategyinvolvesvariousmodalities of magnetic resonance image. In order totoget the edema and Gross Tumor Volume (GTV) these modalities were considered.The morphological operations and a histogram multi-thresholding technique are used in this ABTS algorithm. The image is registered firstwith the standard MR sequence and it has been used asan input. To identify Edema and Gross Tumor Volume (GTV) segmentation step thresholding was used. This method give better accuracyirrespective of Scanner configurations andit identifiesthe thresholds automatically using the histograms.

This work providesan automatic segmentation of brain tumor from the MRI Scan of human head by the help of PSO which has the morphological operation and labelingmethod. Inaddition, this paper flashed a light on the methodological details of the proposed methods, discussion of the results and conclusion.

## II. METHODOLOGY

Numerous image segmentation techniques are available for detecting tumor from MRI images. First, the skull is removed from brain images. Many skull stripping methods available are given in the literature. The skull stripping proposed in this method is carried out using Contour Based Segmentation Method (CBSM) . Particle Swarm Optimization Based Segmentation (PSOBS) is the name given in the flow chart Fig.1.

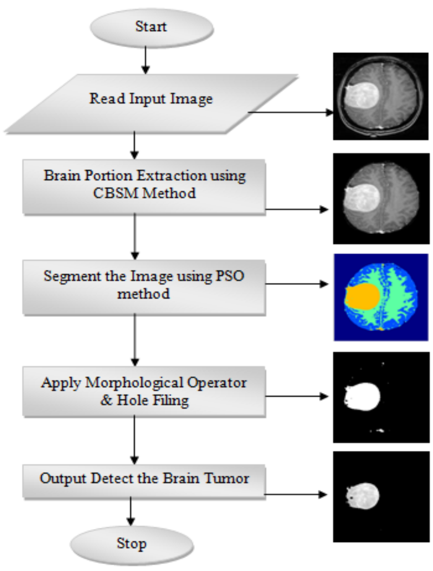


Fig. 1. Flowchart shows over all proposed methodology

In general, segmenting a brain tissue from MRI scan is performed using convolution. Initially, the skull is isolated from brain MRI image to zero in on the brain portion. Numerous methods pertaining the stripping of skull are discussed in the review of literature. This proposed method employs Contour Based Brain Segmentation Method (CBSM)[21]for differentiate the skull from MRI images. [Kennedy, Eberhart 1995], drawing inspiration from the simulation of social behavior of bird flocks, brought out the optimization algorithms based on population called Particle Swarm Optimizers (PSO). In a PSO system, particles refers to the swarm of fly through the search space providing a tissue solution to the optimization problem. The best position visited by itself (i.e. its own experience) and the position of the best particle in its neighborhood (i.e. the experience of neighboring particles) are the two parameters needed to determine the particle's position.By employing a fitness function the particle's performance (i.e. the proximity of the particle from the global optimum) is gauged. It may varies based on the optimization problem. Each particle in the swarm is labeled by taking into account the following characteristics:

$x_i$: Particle's current position;

$v_i$: The current velocity of the particle;

$x_i$: represents personal best position of the particle.

For each step of a PSO algorithm, the velocity $v_i$was updated, specified for each dimension j = 1.. $N_d$

Where $N_d$the dimension of the problem isHence, $v_{ij}$ represents the $j^{th}$ element of the velocity vector of the $i^{th}$ particle. Thus, the velocity of particle i is updated using the following equations:

$$v_{i,j}(t+1) = wv_{i,j}(t) + C_1 r_{1,j}(t)\left(y_{i,j}(t) - x_{i,j}(t)\right) + C_2 r_{2,j}(t)\left(\hat{y}_j(t) - x_{i,j}(t)\right) \quad (1)$$

Where w represents the inertia weight; C1 and C2 represented the acceleration constants; and $r_{1,j}$ and$r_{2,j}$ are the position of particle i, $x_i$, which is computed by the following equation [20]:

$$x_i(t+1) = x_i(t) + v_i(t+1) \quad (2)$$

The fitnessfunction can be defined as like given in equation (3) and this function gives maximized fitness value as a threshold value and it is given by:

$$f(t) = F0 + F1 \quad (3)$$

**Algorithm of PSO**

| |
|---|
| Initialize Swarm: $x_t^n, v_t^n, \tilde{x}_t^n, \tilde{n}_t^n, \tilde{g}_t^n$ |
| Loop: |
| For all the Particles |
| Evaluate the fitness $\varphi$ of each particle |
| Update:$x_t^n, \tilde{n}_t^n, \tilde{g}_t^n$ |
| Update: $v_t^n$, |
| End |

The algorithm can be briefed as follows:

1) Initialization is a process of Initializing theparameters and population with random position and velocities.

2) In the evaluation process of evaluating the fitness value (the desired objective function) for every particle.

3) Finding the $g_{best}$ : provided the fitness value of particle i surpasses its best fitness value ($i.e.\, p_{best}$ ) in the history, set current Fitness value as the new $p_{best}$ to particle i.

4) Finding the $g_{best}$ : after updating, If any $p_{best}$ is found to be improved and reset the Current $g_{best}$ value.

5) Update position: update velocity for each particle by applying Eqn (1) and (2). In this project uses the PSO algorithm to find the cluster centers in the jet color space. Each cluster is considered as unique segment (color map) of the image.

The commonly used simplest segmentation method for medical images based on intensity and also on a threshold value. To begin with, the conversion of the image into gray scale takes place which is further converted into binary image. In this technique, threshold value T is selected from binary image. Histogram is frequently used to select T value from binary image. Basically, it is used to extract object from background. The proposed approach makes use of mathematical morphology operations to bring about the segmentation. The shape of the image features are represented as structuring-elements. The basic idea in binary morphological operation is to probe an image with a defined structuring element. Figure 2 illustrates probing of an image with square structuring element. Most widely used structuring elements are disk, square, cross etc., In our method, we have used disk shape structuring element. The morphological erosion operation is defined as

$$A \Theta B = \left\{ \frac{Z \in E}{B_z \subseteq} A \right\} \quad (4)$$

Where $B_z$ is the translation of B by the vector z.

$$B_z = \{b + z | b \in B\}, \forall_z \in E \quad (5)$$

When the structuring element B has a center and this center is located on the origin of E, Then the erosion of A by B is expressed as:

$$A \Theta B = \cap_{b \in B} A - b \quad (6)$$

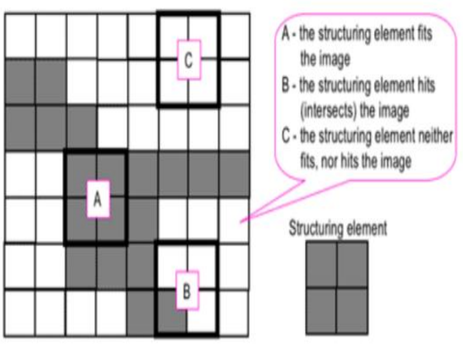


Fig. 2. Probing an image with a structuring elements (white and grey pixels have zero and non-zero values, respectively)

For automatic tumor detection, holes present in the eroded image need to be filled because the presence of holes affects the labeling and counting process and we have applied the holes filling algorithms described in [25]. To achieve this, the morphological reconstruction operation is used as per the following equations:

$$g_m(x, y) = \begin{cases} 1, if\ (x, y) is\ on\ the\ border\ of\ g \\ 0\ , \qquad other\ wise \end{cases} \quad (7)$$

$$g_{HF} = [R_f c(g_m)]^c \quad (8)$$

where g is a binary image and $g_m$ is the maker image with 1pixel for image border. Otherwise 0, $R_f c$ isa reconstructed image of $g_m$ and $g_{HF}$ is hole-filled binary image.

*A. Material Used:*

To experiment and estimate the accuracy of our proposed method, we have obtained brain images from the following dataset:

**Dataset 1: Indian Hospital Scan Centre at Madurai**

The proposed method was put to test with T2-weighted MR brain images procured from a popular scan center at Madurai. Most of it contained MR brain volumes obtained from middle-aged individuals with a tumor in their brain. The three dimension axial T2-weighted spoiled gradient echo MRI Scans were done on two different imaging systems. The machine type is (Avanto) t2_trim_tra_dark_fluid_FIL_1. MR_CT_Scan system with the following parameters: TR=3.5ms, TE=150ms, Flip angle=150 degree, slice Thickness=5mm.

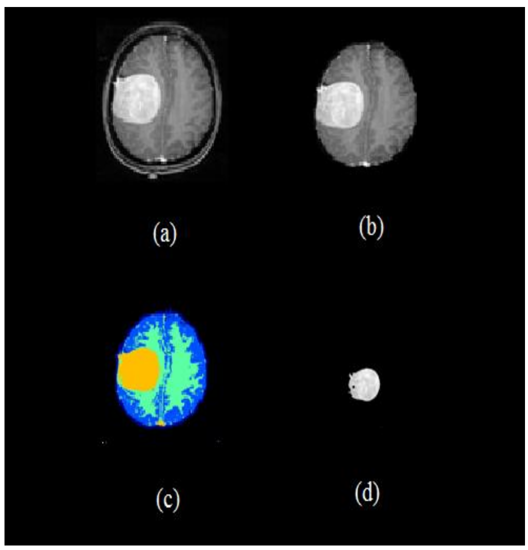


Fig3. Segmentation of Brain Tumor Image by proposed method: (a) Original Image (b) Skull Removed Image (c) Segmented by PSOBS method (d) Detect Brain Tumor

*B. Algorithm 1: Summary of the steps involved in PSOBS:*

Step 1: Read the input MRI image

Step 2: Remove the brain portion using CBSM Method

Step 3: PSOBS is applied to extract different pixels from background.

Step 4: Apply threshold technique on segmented image.

Step 5: Apply morphological operator.

Step 6: Apply Hole Filling operator.

Step 7: Detect the segmented brain tumor.

## III. RESULTS AND DISCUSSION

This method improves efficiency of the brain images obtained from dataset-1. The selected sample images from the brain datasets and results of segmentation obtained using the proposed method is shown in Fig. 3.It shows the segmented skullstripped segmented brain images in column (a) andthe segmented by PSOBS method brain images given in column (b) and the detected Brain tumor images given in column (c) respectively.

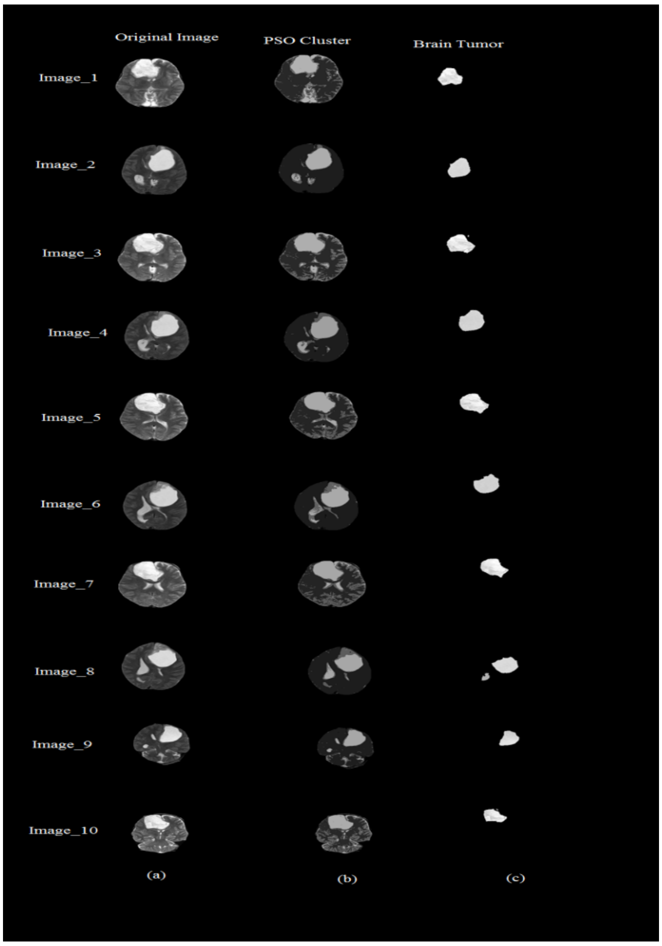


Fig. 4. Segmentation of Brain Tumor Image by proposed method: (a) Skull Removed Image (b) Segmented by PSOBS method (c) Detect Brain Tumor

## IV. CONCLUSION

The brain tissue segmentation using PSOBS is developed to detect brain tumor in MR brain images. This proposed method was tested with images collected from bench mark dataset and it has yielded better segmentation results when compared with the existing methods. This simple automatic segmentation of brain tumor may be used to quantify the neurological damage to brain affected with tumor.

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