

**RESEARCH PAPER**

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## COMPUTATION OF STATISTICAL FEATURES OF BRAIN MR IMAGES

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**Abstract:** As the advancement in the medical field, automation plays an important role. In medical field, visualization and diagnosis, segmentation of medical image plays a vital role. An automatic segmentation method is implemented in this paper for brain MRI based on combination of self organizing map and neuro fuzzy techniques to calculate statistical features of MR brain images. In this paper we tested and compare the two categories, normal (Normal aging -I) and cancerous (Glioma-FDG-PET-II) brain MR images from whole brain atlas.

**Keywords:** Self Organizing Map (SOM), Fuzzy c-means, Inverse Difference Moment (IDM), Average Gray Scale value of Region (AGS), Area of Region (AR), Centroid of Region (CR).

### INTRODUCTION

One of the major causes for the increase in death among children and adults is brain tumor. A brain tumor[5,6] is an abnormal growth of cells within the brain. It is also known as a neoplasm which means "new formation". A tumor can be either benign or malignant i.e. cancerous or deadly. Benign tumors are not harmful whereas malignant tumors are harmful. Both requires therapy to remove it or reduce its size. In benign tumor the cells in them don't get loose and spread throughout the body. In malignant tumor the cells will spread if they are not removed completely very early. Its threat level depends on the combination of various factors like the type of tumor, its location, its size and its area in which it is developed. Diagnosis depends on the type and location of the tumor. In general, malignant tumors grow faster as compared to benign tumors. They are more expected to cause health problems. A tumor is a mass of tissue, grows out of the normal forces that regulates growth[2]. 80,271 people are affected absolutely by various types of tumor (2007 estimates) in India[11,4]. Brain tumors are not invariably fatal. There are more than 120 types of brain tumors[6].

As the brain is well protected by the skull, the early detection of a brain tumor occurs when diagnostic tools are directed at the intracranial cavity. Main brain tumors in children are commonly located in the posterior cranial fossa and in the anterior two-thirds of the cerebral hemispheres in adults. However they can affect on any part of the brain. Malignant gliomas are the most common primary tumors. The largest group of primary brain tumors is gliomas. There are several kinds of gliomas: astrocytomas, brain stem gliomas, ependymomas and oligodendrogliomas. In this paper the images are downloaded from the database of the whole brain atlas given by Keith A. Johnson and J. Alex Becker[3]. Metastasis to the brain is the most scared complication of general cancer and the most common intracranial tumor in adults. The occurrence of brain metastasis is rising with the increase in endurance of cancer patients. Approximately 40% of intracranial neoplasms are metastatic[1]. Fuzzy c-means technique is one of the most popular fuzzy clustering

algorithms[7,9]. It tries to find the most unique point in each cluster, which can be considered as the "centroid" of the cluster and then, the grade of membership for each object in the clusters. For visualization and statistical analysis SOM is a very useful tool. For developing complex application we use SOM. The combination of self organizing map (SOM)

and neuro fuzzy c-means algorithms are used in this paper for calculating the statistical features of the brain MR images.

### TECHNIQUES USED

A self organizing map[8] is an unsupervised clustering property, consists of components called nodes or neurons. At first, the pixels are clustered which is based on their grayscale and spatial features, where the clustering process is accomplished with a SOM network. Clustering separates different regions. These regions could be regarded as segmentation results reserving some semantic meaning. Each node contains a corresponding weight vector of same dimension. A random vector is chosen on every step of the learning process from the initial data set and then the best-matching (the most similar to it) neuron coefficient vector is identified. Select the winner which is most similar to the input vector. The distance between the vectors is measured in the Euclidean metric. Track the node which shows the smallest distance and this node is called as best matching unit. Then update the nodes in the neighborhood of BMU by pulling them closer to the input vector. The result of neighborhood function is an initial cluster center (centroids) for fuzzy c-means algorithms. Fuzzy c-means is a clustering method which allows to finding the cluster center[12]. The membership matrix (U) is randomly initialized in order to accommodate the fuzzy partitioning technique. This iteration will stop when the difference of update membership matrix and membership matrix is less than the termination criterion and this termination criterion lies between 0 and 1.

This approach thus provides a feasible new solution for image segmentation of brain MRI for tumor detection. In brain MRI the image is segmented into Gray matter, White

matter and CSF. If there is some abnormality in the image then extract the tumor region and calculate the statistical features of tumor like, energy, entropy, inverse difference moment (IDM), contrast, mean and standard deviation (SD) which aims to help the radiologist to analyze the statistical information regarding brain tumor to give better treatment to patients.

**FEATURE COMPUTATION**

Brain MRI image divided into two categories, normal and abnormal image. If the image has some abnormality in the region then there is possibility of tumor. We check and extract this ROI automatically and calculating the statistical features of this tumor region. The segmentation of brain tumor from magnetic resonance images is a time-consuming task performed by medical experts. The precise segmentation of brain MRI image into different tissue classes, especially gray matter (GM), white matter (WM) and Cerebrospinal fluid (CSF). In brief we can say, segmentation determines the Regions of Interest (ROIs) in an image. The segmentation process simply determines the pixels in an image which belong to the same item.

In this paper we are showing experimental results of cancerous and normal brain MRI images. For extraction of tumor region we use self organizing map and neuro fuzzy techniques. The detailed description of SOM and neuro fuzzy techniques described in[10].

By using these techniques we extract tumor region. After extracting this region we calculate some statistical features. These features are contrast, energy, entropy, inverse difference moment, mean and standard deviation. And these features are calculating by using the formulae given below.

Contrast: 
$$S_c = \sum_{i=0}^n \sum_{j=0}^m (i - j) p(i, j)$$

Entropy: 
$$S_e = - \sum_{i=0}^n \sum_{j=0}^m p(i, j) \log_2 p(i, j)$$

Energy: 
$$S_{en} = \sum_{i=0}^n \sum_{j=0}^m p^2(i, j)$$

Mean: 
$$S_m = \frac{1}{m \times n} \left\{ \sum_{i=0}^n \sum_{j=0}^m p(i, j) \cdot i \cdot j \right\}$$

IDM: 
$$S_{idm} = \sum_{i=0}^n \sum_{j=0}^m p(i, j) |i - j| \quad i \neq j$$

Standard Deviation:

$$S_d = \sqrt{\left\{ \frac{1}{(m-1)(n-1)} \sum_{i=0}^n \sum_{j=0}^m p(i, j) (i - j)^2 \right\}}$$

In this paper we take an input brain MR image of same size (256\*256) then sub sampling this image into 2\*2 size of matrix. A buffer B is created to store information of M (each buffer node contain reference of M and six vectors i.e. entropy, energy, contrast, mean, IDM, standard deviation.

Then create a self organization map S of size 150\*150 in which each node has the same structure as image buffer B. To calculate vectors of each M, cooccurrence matrix M is used. In cooccurrence matrix firstly, count gray level G of input matrix M. Then create 2D Cooccurrence Matrix (CM) of size G\*G, p=1, q=1. If M(p,q)=I and (p+Δx, q+Δy)=j, then increment cooccurrence matrix by 1 else increment the value of p and q. If the value of q is less than 2, increment cooccurrence matrix by one otherwise p is less than 2 and increment cooccurrence matrix. Then input each M into nodes of B. If the value of M(i) less than 16384 then input each M into nodes of B else input each buffer B[i] into self organization map S. If the value of B[i] is less then 16384 then store it into self organizing map S. Finally self organizing map of size 150\*150 has created. We use fuzzy clustering to find the cluster center. After inputting the SOM and cluster center we can classify the tumor in brain MRI image. Take SOM node X to find

$$I = \sum_{i=1}^n \min(X - C_i) \text{ then Enter } C[i] = X$$

If the value of I is less than s then find I and increment it. Otherwise calculate class K= min (C[i]). If the value of I is not less than the class K contains the tumor.

**RESULTS AND DISCUSSION**

We have tested two categories, cancerous and normal images of brain MRI. In cancer category we have tested Glioma- FDG-PET-II test images and for normal brain images we tested normal aging-I category. For normal brain MR image our software calculates some minor abnormality in the image and the calculated value of area of that region are either negative, zero or very small value which we can assumed to be negligible. In Glioma-FDG-PET-II there are total 18 images and all the images shows the tumor detection. Our result matches with 100% accuracy. For the normal category of brain MRI we tested normal aging-I category. In this category there are total 51 images and all the images shows absolute normal result, so the result matches with 100% accuracy. As we built the GUI for automatic detection of tumor in brain MRI it calculates the tumor properties of that region. It also checks whether the image is normal or having tumor. We find the statistical properties of image and tumor of these brain MR images which are helpful for the doctors to better analyse the image. Results of these images are shown in Table I, Table II.

**CONCLUSION**

In this paper we use hybrid technique of SOM and fuzzy c-means. We use this hybrid technique to find the statistical properties of the images. The database is taken from the whole brain atlas by Keith A. Johnson and J. Alex Becker. From this database we have taken two categories normal and cancerous brain MRI. For cancerous brain MRI we tested Glioma-FDG-PET-II category. Result is 100% accurate. For the normal brain MRI we tested normal aging-I and the accuracy is 100%. We calculate the statistical properties of the images which are very helpful for the doctors to better analyse the image. It saves the time of doctors. They can see result many times, which are helpful for prepare the case study of the patients as he maintains the database and can

see the progress of the patient when he again calculates the properties after given the treatment.

Table I: Statistical properties of Glioma- FDG-PET-II brain MRI

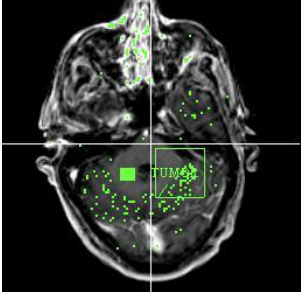
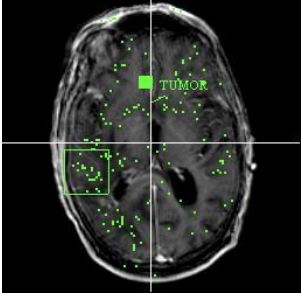
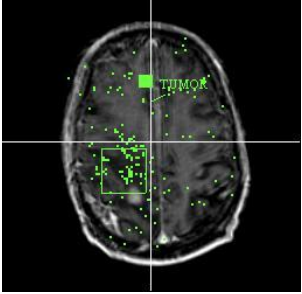
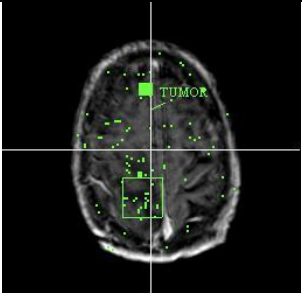
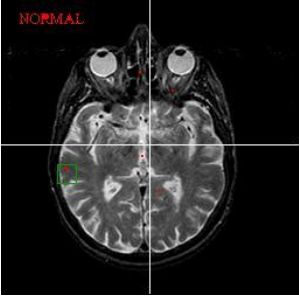
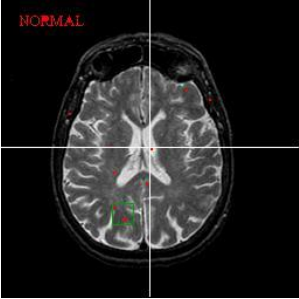
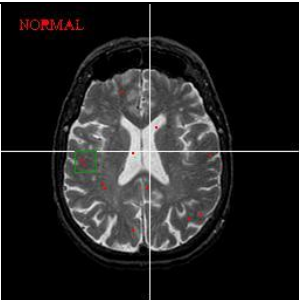
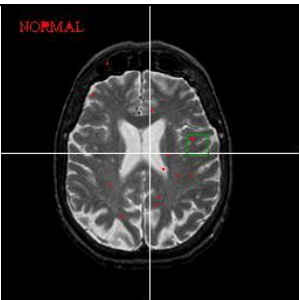
Image	Properties of Tumor Region								
	AGS	AR	CR	Energy	Entropy	IDM	Contrast	Mean	SD
	47.0	680	152,152	1.1980188 90309566 3E-11	-1.933315 15357004 18E-4	4.82052 2313233 683E-6	1.349746247 7054323E-5	1.349746 2477054 323E-5	2.522792 0648049 14E-7
	45.0	544	152,72	1.1500089 79437920 8E-11	-2.615936 68868144 3E-4	0.0	1.822423093 7454442E-5	1.822423 0937454 442E-5	5.675396 4087609 1E-7
	42.0	564	152,104	1.9780154 44633223 8E-11	-2.531136 32735744 35E-4	6.23460 5320708 098E-6	1.822423093 7454442E-5	1.822423 0937454 442E-5	3.529408 5274252 18E-7
	47.0	328	168,120	2.9118701 69196728 E-11	-3.501899 43483580 75E-4	7.48314 7950814 765E-6	2.544270303 277019E-5	2.544270 3032770 19E-5	5.934526 2565398 33E-7

Table II: Statistical properties of Normal aging-I brain MRI

Image	Properties of Tumor Region								
	AGS	AR	CR	Energy	Entropy	IDM	Contrast	Mean	SD
	-92.0	-16	152.56	4.190951585 769653E-9	-0.0026864 530008274 246	1.5258789 0625E-5	2.4414062 5E-4	2.441406 25E-4	4.861934 46968802 6E-5
	624.0	4	184,104	1.814888525 4233422E-9	-0.0019692 165086058 148	2.8577960 67672611 E-5	1.7146776 40603566 4E-4	1.714677 64060356 64E-4	2.115603 36874886 93E-5
	345.0	8	136.72	1.814888525 4233422E-9	-0.0019692 165086058 148	1.9051973 78448407 3E-5	1.7146776 40603566 4E-4	1.714677 64060356 64E-4	1.267992 75355550 45E-5
	271.0	12	120,168	1.996377377 9656763E-9	-0.0019560 106866929 974	3.8103947 56896814 6E-5	1.7146776 40603566 4E-4	1.714677 6406035 664E-4	1.956737 27214443 57E-5

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