Available online www.jsaer.com

Journal of Scientific and Engineering Research, 2019, 6(1):193-197

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

An Enhanced Application of Fuzzy C-Mean Algorithm in Image Segmentation Process

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Abstract This research work is focus on an enhanced application of Fuzzy C-Means Algorithm in Image Segmentation Process. The application computer in the areas of automated medical diagnosis is no doubt the backbone of any effective decision and treatment that may arise due to the cause of brain tumor. Several researchers have shown that the causes of most death are as a result of incorrect diagnosis of the affected areas of brain arising from brain tumor. It is obvious that the chances of survival can be enhanced if the tumor is detected and classified correctly at its early stage. Segmentation of brain tumors in magnetic resonance images (MRI) is a challenging and difficult task because of the multiplicity of their possible shapes, locations, image intensities. In this research, it is intended to summarize and compare the methods of automatic detection of brain tumor through Magnetic Resonance Image (MRI) Machine by application of an enhanced Fuzzy C-Mean. The proposed method can be successfully applied to detect the contour of the tumor and its geometrical dimension. In this research work we will highlight the ways for detection for both mass and malignant types of tumor cells by use of a 3-D Analyzer tool for more accurate result since the malignant tumor is difficult as compare to mass tumor. We will use the Structural System Analysis and Design Method (SSADM).

Keywords Enhanced, Fuzzy C-Means, Algorithm, filtering technique, Image Segmentation

Introduction

Most of the problem that is face by man or organization is in the areas of image identification, these problems may arise as a result of complexities in image that is captured from either satellite tv, x-ray or magnetic resonance image machine as the case may be. Hence there is need to perform filtering or de-noising technique on the image before the process of image segmentation.

Segmentation is the process of splitting image into different parts for proper analysis. In this research paper we will outline the processes that are involve in the used of an enhanced fuzzy c-means algorithms in the domain area of brain tumor to detect the presence of tumor in it early state of formation. Tumors are of two types name malignant and Benign or mass [1].

Related Work

A lot of research papers related to medical image segmentation were studied. Below are the report of some of the literature survey presented:

Color-based segmentation was introduced using K-Means clustering for the brain tumor detection. The developed algorithm shows better result than canny based edge detection. Nandha [2] developed an intelligent system to diagnose brain tumor through MRI using image processing clustering algorithms such as fuzzy c-means along with an intelligent optimization tools such as Genetic algorithm (GA), and particle swarm optimization (PSO).

Yan et al [3] also developed a novel image segmentation algorithm called W-SPK which combined watershed and K-means clustering method based on simulated annealing particle swarm optimization which was use to overcome the short realize a fast and accurate image segmentation process.

Sasikate et al [4] developed an automated segmentation of malignant types of tumor in magnetic resonance image (MRI) of brain using optimal texture features. In this case, the texture features are extracted from normal and tumor region (ROI) in the brain images under study using spatial gray level dependence method and wavelet transform.

What is Fuzzy C-Means

A fuzzy c-means is a data clustering technique in which a dataset is grouped into n clusters with every datapoint in the dataset belonging to every cluster to a certain degree. Let consider a scenario in which a certain datapoint lies close to the centre of a cluster will have a high degree of belonging to that cluster and another datapoint that lies far away from the centre of a cluster will have a low degree of belonging or been a member of that particular cluster.

However, medical images are considered fuzzy due to the uncertainty present in terms of region/boundaries, non-uniform intensity variations. Fuzzy c-means is one of the clustering method that was proposed by J.C. Bezdek [5]. But the fuzzy c-means clustering algorithm works well on segmenting most noise free images it fails to segment image corrupted by outliners. The traditional fuzzy c-means (FCM) leads to its own robust mainly due to

1. *Not utilizing the spatial information in the image*
2. *Use of Euclidean distance.*
3. *To overcome the first problem many researcher incorporated the local spatial information into traditional fuzzy c-means (FCM)*

Problem Definition

In the existing system there has been different approaches used to detect the presence of brain tumor in it early stage of formation opined by the following researchers

Pritee G. [6] applied fuzzy c-means algorithm for brain tumor segmentation, the detection of brain tumor was done on mass type of tumor. In this approach it fails to address the problem of segmentation of malignant tumor which serves as my motivation for this research paper.

B. Prasanti [1] developed a Gene-fuzzy c-means clustering technique that was use to detect the presence of brain tumor. In this approach it has a high objective function of computational complexity as result it fails to address the problem of high objective function computational complexity and also do not make use of the 3D representation of brain and 3D analyzer tools in order to obtain a more accurate result in the brain tumor detection.

Proposed Scheme

In this research paper we will improve on an existing fuzzy c-means algorithm that is use in detection of brain tumor at it early stage of formation. The advantages of using enhanced fuzzy c-means clustering technique is to ensure that we obtained a more accurate result through the use of 3D image representation of the brain and the 3D analyzer tools which will be used for analysis.

Multiple Kernel Fuzzy C-Means (MKFCM) with Spatial Biasing

The application of Fuzzy c-means clustering technique will be largely limited to spherical clusters only, but with the application of kernel fuzzy c-means algorithm attempts to solve this problem by mapping data with nonlinear relationships to appropriate feature spaces. Kernel combination, or selection, is crucial for effective kernel clustering. For most of the applications, it is not easy to find the right combination. In this paper a multiple kernel fuzzy c-means (MKFC) algorithm which extends the fuzzy c-means algorithm with a multiple kernel learning setting. By using multiple kernels and automatically adjusting the kernel weights, MKFC is more important to ineffective kernels and irrelevant features. It makes the choice of kernels less crucial.

Experiments on both synthetic and real-world data demonstrate the effectiveness of the proposed MKFC algorithm [7].

It has the ability to combine different information from multiple heterogeneous or homogeneous sources in the kernel space. Specifically, in image-segmentation problems, the input data involve properties of image pixels sometimes derived from very different sources. Therefore, we can define different kernel functions purposely for the intensity information and the texture information separately, and we then combine these kernel functions and apply the composite kernel in MKFCM to obtain better image-segmentation results.

However, the Multiple Kernel Fuzzy C-Means (MKFCM) still do not provide a spatial neighbor pixel information. Hence, the MKFCM is very sensitive for the noise image segmentation. In order to address this problem of noise in an image segmentation, a novel Multiple-Kernel fuzzy c-means (MKFCM) methodology with spatial information is introduced and is represented as MKFCM-S I and MKFCM-S2. The objective function, cluster centers and cluster centers and membership functions for the proposed method are given below.

$$O_m^G(U,C) = \sum_{i=1}^{c}\sum_{j=1}^{n} U_{ij}^m (1 - K_M(x_j, C_i) + \sum_{i=1}^{c}\sum_{j=1}^{n} n_i U_{ij}^m (1 - K_M(\overline{x_j}, C_i) \quad (1)$$

Where $K_M(x_j, C_i) = K_1(x_j, C_i) \times K_2(x_j, C_i)$, $K_1(x_j, C_i) = \exp\left(\frac{-\|x_j - C_i\|^2}{\sigma_1^2}\right)$

$K_2(x_j, C_i) = \exp\left(\frac{-\|x_j - C_i\|^2}{\sigma_2^2}\right)$

x is the mean for MKFCM_S1 and median for median for MKFCM_S2 of the neighbor pixels σ_1^2, σ_2^2 are the variances.

$$U_{ij} = \frac{((1-K_M(x_j,C_i)) + n_i(1-K_M(x_j,c_i)))^{-1/(m-1)}}{\sum_{i=1}^{c}((1-K_M(x_j,C_i)) + n_i(\overline{x}_j,C_i)))^{-1/(m-1)}} ; i = 1,2,\ldots\ldots C \quad (2)$$

$$C_i = \frac{\sum_{j=1}^{n} U_{ij}^m (K_M(x_j,C_i)x_j + n_i K_M(\overline{x}_j,C_i)\overline{x}_j)}{\sum_{j=1}^{n} U_{ij}^m (K_M(x_j,C_i)x_j + n_i K_M(\overline{x}_j,C_i)} ; i = 1,2\ldots\ldots C \quad (3)$$

$$n_i = \frac{\min_{i \neq j}(1-K(c_i,c_j))}{\min_k(1-K(c_k,\overline{x}))} ; i = 1,2\ldots\ldots C \quad (4)$$

Proposed Algorithm for MKFCM with Spatial Biasing

Step 1: Browse for the file path; load the 3D image representation from database of MRI machine scanned to be processed (JPEG format)

Step 2: Check if the image is RGB if not then convert the image to gray image.

Step 3: Convert the 3D image representation to double to increase the pixels value

Step 4: For MKFCM, predefine the clusters centre C_i (c= 3 clusters)

Step 5: Get the size of the whole image

Step 6: Convert the input matrix to a vector

Step 7: Compute the membership value by using equation 2

Step 8: Update the cluster centre by using equation 3

Iteration Process Start:

Step 9: Update the membership value U_{ij} by using equation 1

Step 10: Update the cluster center C_i by using equation 2

Step 11: If $|C_{new} - C_{old}| > \varepsilon$; ($\varepsilon = 0.001$) then goto Step 1

Else stop Assign each pixel to a specific cluster for which the membership is maximal

Detection stage

In this stage, the detection of segmented image will be achieve by using the binarization method in the approximate reasoning step the area of the tumor is calculated. That means the image having two values either white or black (1 or 0). We represent the binary image as a summation of the total number of black and white pixels as given in the formula below:

Image, $I = \sum_{W=0}^{m}\sum_{H=0}^{m}[f(0) + f(1)]$ (5)

Pixels = Height (H) X Width (W)

f (l) = black pixel (digit 1)

f (0) = white pixel (digit 0)

No_of _White, $P = \sum_{w=0}^{m}\sum_{H=0}^{m}[f(0)]$ (6)

Where,
m = maximum image size
P=Total number of white pixels, (height x width)
1 Pixel = 0.264
The formula for area of tumor size

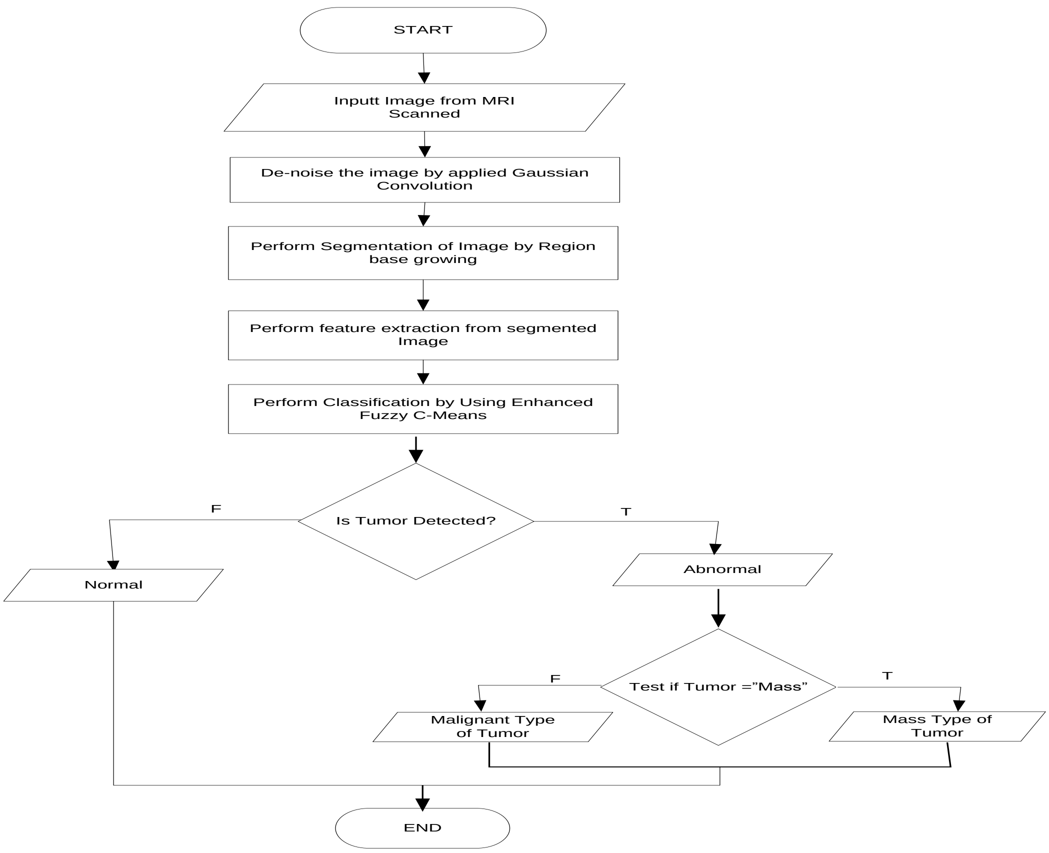
$$\text{Size\_of\_Tumor } S = [(\sqrt{P}) \times 0.264]\ mm^2 \quad (7)$$

Detection Stage Algorithm Steps

The algorithmic steps used for brain tumor detection is as follows:

Step 1: Use .JPEG MRI images from a database or real-time system as input.
Step 2. Checks whether the input image format is as specified and move to step 3
Step 3: Verify that image is gray image. If not then convert to gray-scale using rgbtogray ( ) function in Matlab.
Step 4: Find the edge of the grayscale image using binarization and thresholding method.
Step 5: Calculate the total number of white pixels (digit 0) in the image using equation 6
Step 6: Calculate the Size of the Tumor Using equation 7
Step 7: Test if Tumor Area > 6mm2 then display message "Abnormal"
else display message "Normal:" .
Test if Tumor = "Mass" then display message "Mass Type"
Else display message "Malignant Type"
Step 8. Stop the process.

Flow Chart Diagram



Conclusion

In conclusion, we have discussed the processes that are involved in image segmentation by the application of an enhanced Fuzzy C-Means algorithms which is achieved by Multiple Kernel Fuzzy C-Fuzzy Means with spatial biasing, with the aim to ensure that brain tumor are detected at it early stage of formation and also determine if the tumor detected are either mass or malignant types of tumor before treatment can be administered on patients. We also presented the algorithm for Multiple Kernel Fuzzy C-Means (MKFCM) with spatial biasing, the algorithm for detection for tumor affected area and flow chart showing the detected area of tumor which is geared towards ensuring that we obtained a more accurate result.

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