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Brain tumor image classification using brain tumor in the context of medical image processing

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ABSTRACT

The brain tumor classification using MATLAB is a great need to improve the image processing techniques in MATLAB. Though great attention has been given to this field, the area of great interest in image processing is image filtering, image segmentation, and detecting the features from the images. MATLAB can improve it by using smoothing of images, efficient image segmentation, extraction of different features from the image, and the classification of the images. The two well-known methods used for image segmentation are K-means clusters and those operations for morphological classification. The two most commonly used and efficient filters are used for this process, i.e., median and plantlet filters. To diagnose a disease, especially a tumor in any part of the body, it's necessary to use the most efficient image segmentation methods. Research on image segmentation has revolutionized this process in image segmentation. To detect the brain tumor, the technique that everyone adopts is magnetic resonance images. While extracting brain tumor features from the images, the research focuses on tumor location, the tumor's texture, the color of the tumor, edge of the tumor, and specific region of the brain tumor. The images features are extracted based on the above criteria, and to find whether the patient has the tumor or not, the images are classified.

Keywords: MATLAB, Medical Image Processing, Brain Tumor, Feature Extraction, classification, K-Means Cluster, Morphological Classification.

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INTRODUCTION

In this paper, the main focus is on the modern-day image processing techniques that will help detect the tumor in the brain and cancer in certain parts of the body. As brain tumors and cancer are deadly diseases, there needs to be at least the most efficient optimizing techniques to help the scientists find how fatal the condition of the cancer is. This can be improved by the MRI method and image processing techniques.

Image classification is also a significant step in this case. Here, attention is being given to the image, classified into different classes. The most common image classification techniques used in this study are Boltzmann, random forest, K-clustering, and support vector machine.

In this paper, the focus is given to combining various image segmentation methods, many image classification methods that will provide the most optimized results. The segmentation technique used here is grey-scared, and it's one of the essential methods of deep learning and deep neural networks.

Using the techniques mentioned earlier and methods, the results obtained for image segmentation and image filtering and classification will be much more efficient. They will help us to diagnose the disease with less time required. Figure 1 shows the steps for the detection of the brain tumor.

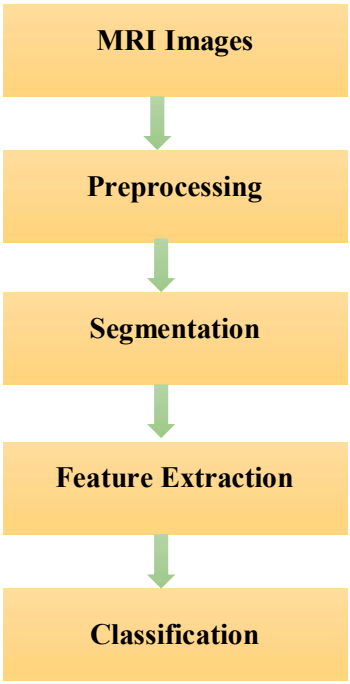


Figure 1: Steps in Brain Image Classification

LITERATURE REVIEW

Usually, a brain tumor is a kind of additional tissue formation that can present in any body part or organ; apart from a brain tumor, other defects are brain tumors, bone tumors, lung tumors, etc. Through paper [1], the author tells us about image processing, and the second module is filled with the information that is matched with the Support Vector Machine and Neural networking modules and a set of classifiers that match the medical image processing techniques. The main objective of this paper is to file a segmented tumor grade option with enough methods that are related to brain magnetic resonance and to identify the brain tumor disease earlier by utilizing some of the physician knowledge that is combined with the machine learning modules to enhance the way of pre-treatment is a better method [2]. Analyzing a medical report is one of the riskier tasks sometimes, the doctors cannot be able to identify the report analysis in such faster ways, in such case in the paper [3], and the author has initiated a few medical tips if the system gets combined with the technological concept. In contrast, the Bees Swarm Optimization and the neural network classifications are used the most to get a clear MRI image type. If a person gets affected by cancer, it is more essential to take the precautions previous; for example, the person should impotent by the radiologist, with the help of Nano segmentation and a few of the deep learning modules, the author have shown 95% accuracy about the diagnose of cancer and feature extraction methods [4]. If a person's brain is filled with both the standard and abnormal cell types, it can be said to be a brain tumor.

In contrast, while having a scanning option of the brain, the doctors would rename it as MRI images; this paper [5] does describe the extraction of brain tumors and does calculate the distinct features of shapes and their presence. Both the neurologist and radiologist are the two doctors who handle identifying the early presence of cancer; MRI is nothing but Magnetic Resonance Imaging through this paper [6], the author approaches the set of classification and cutting-edge object detecting frame concept and the subset analysis. The author of the article [7] knows the readers about the impact of brain tumors and how the classifications are separated into different segregation sets under the concept of deep learning models. Most commonly, the author has initialized the idea called the RNN classifier tool. In the year 2017, world health organizations have reported two sets of significance; for example, the first one declares about the classification on adenohypophysis cell lineage according to the diagnosis methods, whereas the second implementation is about the atypical adenoma that is eliminated with an average predictive value [8]. Most commonly, the author who completed the article [9] Details the significance of MRI and its classification like the other paper. Still, he also focuses on deep learning modules that come across the image segmentation process to analyze the metaheuristics method formation. In this article [10], the author mainly focuses on the specificity, constancy, and exclusiveness; this paper's main reason is to classify the tumors and diagnose the criteria within the indeterminacy method of histopathological methods.

MATERIAL AND METHODS

Steps of the proposed model

The following are the steps required for image processing for the detection of brain tumors as represented in the Figure 1.

1. Data-acquisition
2. Pre-processing
3. Segmentation
4. Features extraction
5. Classification

In the **data-acquisition step,** data is collected for the image processing. Data is selected with the following properties.A total of the ten images has been selected and is given in Figure 2.The dimension of each image is 256x256.These images with the help of an MRI device using laser disks are being selected.The mean value of the image is represented by the following Equation (1).

$$B = {}^{1}/_{\sqrt{9} * [u(x/3\,, y/3)]} \qquad (1)$$

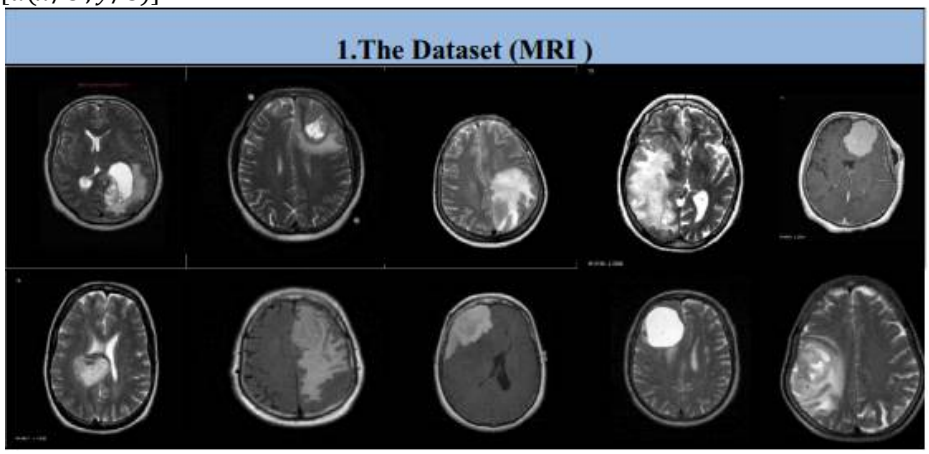


Figure 2: Random sample of Brain images

The next step in this technique is the process of pre-processing:

In the pre-processing step, attention is being given to the smoothing of the images and the enhancement of the images. To smooth images, some filters can be used. To get rid of the noise from the images, the common median technique is being used here. The median filter uses the non-linear method and the average value of all the pixels are being considered here. The other filter that can be used for smoothing is the slanted transform. The results of the different filters are being compared by measuring the signal to the noise ratio and the error measured by the mean of the square. The formula for the mean square image is calculated as in the Equation (2).

$$Mean\_Square\_Error = 1/m * n[I - K]^2 \qquad (2)$$

Where, m in the above formula is the height of the image and n in the above equation is the height of the image.The following figure shows us the pre-processing results of the image in Figure 3.

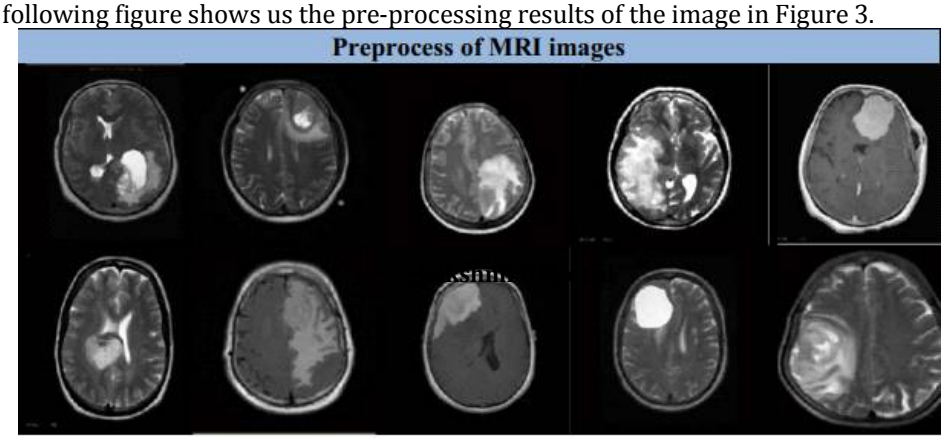


Figure 3: Results of Preprocessed MRI Images

The following Table 1 shows the mean square error that is being calculated for each of the ten images.

Table 1: Mean Square Error for the sample brain images

Image Number	MSE	PSNR
1	13.1924	36.9616
2	8.3998	38.9221
3	5.9886	40.3915
4	16.5557	35.9753
5	10.3917	37.9979
6	11.3638	37.6096
7	5.9732	40.4027
8	2.7104	43.8345
9	7.4656	39.4342
10	9.5222	38.3774

SEGMENTATION

The next step in this is the segmentation of the images. The process of image segmentation is to divide the original image into very small portions. This will help us to find the important information from the images.One of the most important techniques that are being used for the image segmentation is the clustering of the images by K-means. The quality of the clustering is calculated by measuring the mean distance between data points to their respective clusters centers. The following Equation (3) is being used for the K-means clustering.

$$J = \left|k_i - c_j\right|^2 \quad (3)$$

Figure 4 represents the results obtained by K-means.

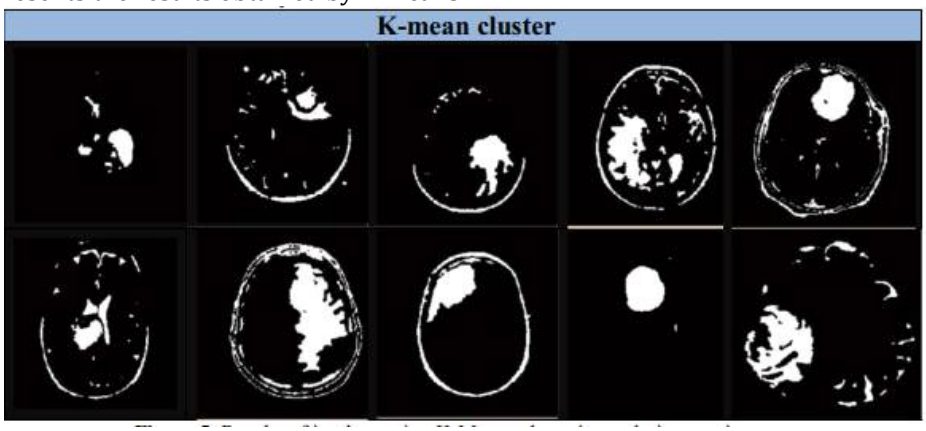


Figure 4: K-Means Cluster Results for the Brain Images

FEATURE EXTRACTION

Where ΔA is the one-pixel area that which the scale changes. When using a rotation transformation owingto the discretization of the image, tiny errors in the computation of the area are expected.The next step in the image processing and probably the most important is to extract different features from the image. The criteria for the image feature extraction is to consider important properties of the images such as the location of the image, shape of the images, size of the images, and configuration of the images. The region of the interest is defined by the following Equation (4).

$$AS = \int I(x,y)dy.dx \quad (4)$$

$I(x,y)$ value is set to the 1 if the shape of the pixel is being considered into (x,y) belongs to the S. If it's not the case, the value of (x,y) is being set to the zero. The integrals are obtained by the Equation (5).

$$A = \int I(x,y)\Delta A \quad (5)$$

ΔA in the above equation is the area of the single-pixel and its scale is changeable. The Equation (6) represents the mean of the image obtained by the sum of all the pixel values.

$$M = 1/m * n(f(x,y)) \quad (6)$$

The hyperplane of the support vector machine is presented by the Equation (7).

$$F(Y) = zT * \phi(Y) + B \quad (7)$$

CLASSIFICATION OF BRAIN IMAGES

With the help of fuzzy logic, mapping is being created. This mapping will help to form a logic on which basic a decision will be made or the pattern in the images can be identified. This overall process involves the use of the following important steps and functions.

- Membership functions
- Logical operations

- If and then rules
- If and then the conclusion

In the training steps, these rules will be extracted for all the features that are being extracted. The features then obtained are further divided into the following classes

- High
- Low
- Medium.

Similarly, the output is divided into 2 main classes. High value will indicate the presence of the tumor; Low will indicate that there is no clue of any abnormal or tumor in the brain. Then this classification will also tell us the size of the tumor which will help us to diagnose the condition of the patient. If the tumor is large the condition of the patient is critical and if it's small then the condition of the patient is not much critical. The PSBR error is being calculated by the following Equation (8).

$$PSBR = 20 * \log 10 * (2^{n-1}) * Mean\_Square\_Error \quad (8)$$

The preceding Figure (5) represents the class of the tumor detected with the help of the image processing technique mentioned above.

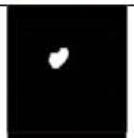
No. images	Tumor size	Shape	class	No. image	Tumor size	Shape	class
1	1779		Low	6	3693		Medium
2	3146		Medium	7	8843		High
3	3440		Medium	8	4969		Medium

Figure 5: Tumor Classification Results

The specific classification process that is being used here is the classification based on the rules which will represents the size of the tumor which is an important step necessary for the purpose to find which type of tumor it is. It will also let us know the condition of the tumor and will help us find the condition at which stage of the treatment is required in this case.

The rule-based classification has many important advantages that it's very easy to use and easy to understand also as compared to the other classification methods its results are very much accurate and give optimized results.

The main rules that need to be followed in here are as follows.

- If the area is less than 500 then its low
- If the area is between 2500 and 5000 then the output is medium
- If the area is more than 5000 then the output is high.

Two sets of data are being used here which are being calculated from the open-source which contains MRI scan images of the patients with 9 slices for every single patient. The dataset that's being used here goes through the image processing step in machine learning where each image is processed, segmented, and classified to analyze the images and draw the solutions from them.

The data is then divided into several parts and the specific sections of the brain images are analyzed and we can tell whether any section of the brain has a critical or normal stage of the tumor.

CONCLUSION

The algorithm that has been discussed in the above paper is very much easy to detect the tumor inside the human brain. The main steps are the pre-processing and the segmentation of the images data obtained from the tumor with the help of MRI. To remove the noises from the images, two filters are being used. The classification steps help us understand the stage of the tumor by categorizing it in the high, medium, and low-class output.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest for this study

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