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A survey on detection of brain tumor using computer vision and machine learning technique

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Abstract
An automated neurological disorder detection system which is intended to localize brain tumor using computer vision on Magnetic Resonance Imaging (MRI). The most widespread and aggressive brain tumors are gliomas, at their highest point, they lead to a much more limited life span. Therapy preparation is also a crucial step in ensuring a better quality of life for patients with oncology. Magnetic resonance imaging (MRI), It is used for inspecting the mechanisms & components of the human body also for medical diagnosis, to find the stage of the disease and to follow up without ionizing radiation exposure. The substantial spatial and structural changeability of brain tumors makes the process of segmentation more difficult. Consequently, depending on Convolutional Neural Networks (CNN), an automated and consistent segmentation approach is used. Through use of small kernels facilitates the construction of a deeper architecture, Owing to the fairly low number of network weights, with such a positive impact on overfitting. It also investigates the use of normalization of intensity as a pre-processing phase, which is not ubiquitous in segmentation techniques based on the Convolution Neural Network, but it has successfully demonstrated effectiveness in segmenting brain tumors in Magnetic Resonance Imaging (MRI) together with data augmentation.

Keywords: Deep learning, brain tumors, convolutional neural networks (CNN), magnetic resonance imaging (MRI)

1. Introduction
The human brain is a highly specialized and complex organ consisting of tissues that are incredibly spongy and soft. It is largely termed as the central processing unit of the human body. Our brain just allows us to communicate the expressions, perform our acts, and exchange beliefs, thoughts and emotions. Under certain alter conditions-brain growth of the tissue is uncontrolled. This excessive increase of tissue mass is considered a tumor and is called a brain tumor if it is inside the brain. Tumors tend to create new vessels in the blood. Malignant tumor detection becomes quite difficult to identify in mass tumors. Normally the brain tumor affects CSF (Cerebral Spinal Fluid). CSF leaks may lead to meningitis, brain infections, or stroke which can be life-threatening. So early detection and diagnosis properly on time is necessary.
The intended system is such that it detects the tumor and its shape by using computer technologies like image processing, in essence, it is a framework for analyzing and processing such captured images for detailed data, such as color and resolution, in digital format. A scan-based strategy for imaging has been used for the identification and screening of brain tumors applying the principles of processing images and MRI (Magnetic Resonance Imaging). This technique is not limited to the identification of tumors within the brain, it may as well, however, scan the human body's entire internal structure to identify any tumor.
There two main techniques used for this system:

Convolution Neural Network: The simple application of a filter applied to input, this filtering of the input which prompts an activation, is a convolution. When the same filter is repeatedly applied to the input, an activation map called a feature map displays the positioning and intensity of the exclusively extracted features of an input, such as an image.

K-means clustering: It is an iterative and evolutionary method that seeks to split the dataset into different non-overlapping datasets sub - category (clusters) identified by Kpre-defined, where a single category corresponds to every other data point. This attempts to keep the data points of the same category(cluster) as close as feasible while still keeping the data points of the different categories(clusters) as distinct (far) as viable. It assigns the data points of a cluster in such a way that the sum of the square distance between the data points and the middle of the cluster (the arithmetical mean across all data points that belong to the cluster) is at least the same.

2. Background and Related Work

The recommended method for imaging modalities for brain tumor analysis is magnetic resonance imaging (MRI). A lot of details and information can be gained from a single MRI evaluation. The radiologist is then presented with a wider range of sources of information but comparably few research tools when diagnosis is needed. In this work, we propose an automatic data-driven recognition of tumors method in which localization (segmentation) and characterization are both involved in identification (signature).

Several attempts have been made, although much less prominent than in traditional MRI analysis [1], to analyze multi-parameter quantitative MRI data to test the information quality of the affected region of the organ. Most often, they consist of two phases, localization and characterization, whose variability and precision can be handled by automated selection of ROI and standardization of quantitative feature extraction, respectively, in two main ways. Most methods focus on one of the other perspectives: segmentation approaches are usual approaches to segmentation based on a few standard MRI maps, whereas a preliminary manual ROI delineation is dedicated to more specialized feature extraction techniques.

The proposed scheme enhances user search for better results of finding and localizing the ROI (Region of Interest) that is the area affected by the tumor [2]. Although the data augmentation was not explored deeply for Brain Tumor Segmentation.

The paper provides a Human Brain Tumor research by using MRI imaging technique to capture the image. Here, the region of the brain tumor is measured to determine the stage or degree of tumor severity [3]. Image Processing strategies are used for determining the portion of the brain tumor. K-Means and Fuzzy C-Means are put to use efficiently to estimate the area and stage of brain tumor which conquer the drawbacks of thresholding and region growing algorithms. The output of the K-Means algorithm is used as input for the Fuzzy C-Means which leads to accuracy of edge of the tumor.

This illustrates the method of Brain Tumor Diagnosis and Classification with fuzzy logic and neural networks. In the Brain Tumor technique, which generates Devising Classifiers software objects to create structured models such as the Integrated Structure for Analysis and Classification of Brain Tumor, the latent facts are evaluated, extracted and transformed [4]. The system is only effective on similar kind of tumors and cannot deal with new kind of tumor. Which leads us to the conclusion that to increase the accuracy in finding the tumor we must introduce various types of tumor to the system while training it.

Some other systems have used different deep learning neural networks like ANN which resulted in accurate results, but those schemes and systems required high hardware processing which gave slower yields [5].

3. Analysis of Related Work

In this section, we will discuss, what most of the related works mentioned above provide to us and what were the drawbacks in the schemes proposed by these papers.

A system has been previously proposed which uses the principles of Pre-processing the MRI image then using Convolution Neural Network and lastly applying Clustering to the results obtained, although the data augmentation was not done thoroughly which limited the results by a large margin. To maximize the size of training datasets and to minimize over-fitting, Data Augmentation can also be used. We narrowed the data augmentation to rotating operations because the group of the patch is extracted by the central voxel. Some authors still recommend image translations, but this could result in attributing the patch to an incorrect class for segmentation.

It is possible to describe image processing as an increasing area of research where MRI processing is a highly challenging field [6]. It is possible to use medical imaging technology for imaging various internal organs and areas of the human body for medical diagnosis. A very drastic and life-threatening brain disease is a brain tumor. In image processing, image segmentation plays a significant role, as it is used to identify suspicious and affected components from MRI (magnetic resonance imaging) images. The study suggests segmentation of the MRI image of the human brain using the K-means clustering algorithm followed by morphological filtering used to avoid the misclustered regions formed after segmentation.

Another software was developed that offers procedures of the Probabilistic Neural Network for the compartmentalization of individual brain images. The Neural Network approach that was developed involves compartmentalization and, in particular, the step elimination of that function. In the categorization process, the Neural System classifier was invented based on back propagation. This classifier has been used as a standard, harmless, and cancerous brain tumor graphics to classify subjects. The Substantial element research (PCA) has been one of the best techniques used in image blending and perception. It suggests a computer-controlled way of sorting brain advances explicitly into dangerous or harmless.

4. Architecture of the System

The project provides us with many reasons to implement the irresponsibility of professional agriculturists. It gives an all-time continuous control over the spread of a disease, but its cost may be high as a result and by means of considering the cost this gives us accuracy in plant disease prediction and also gives a powerful recommendation of pesticides by considering the cost. The following figure illustrates the proposed system's architecture.

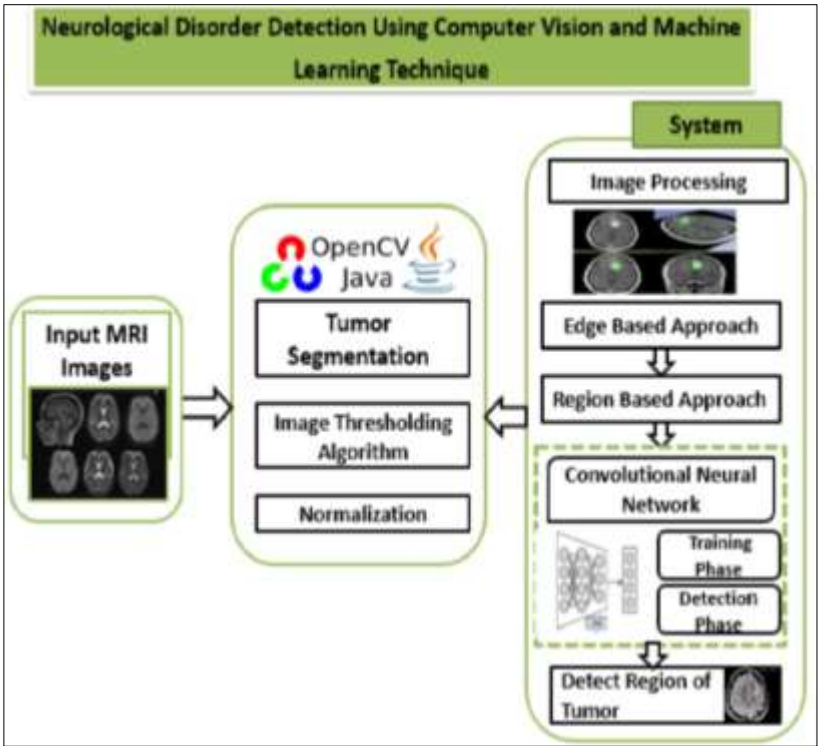

Fig 1: System Architecture

1. **Image Pre-processing:** Apply Processing on input Image (Open CV image).

a) Detection of edges: Edges are the sharp black shadow that encompasses objects.

b) Apply grayscale conversion

2. Boundary Based Approach: Pixels are assigned to groups in Thresholding in accordance with the group of values in which a pixel resides. Thresholding is the relatively simple most often used segmentation process. Because of a single threshold, t, the lattice location pixel (i, j), with a Gray scale value of fij, is assigned to category 1 if fij $\leq$ t, or else the pixel is assigned to category 2. This approach is also called as Thresholding.

3. Edge Based Approach: An edge filter is applied to the image in edge-based segmentation, pixels are classified as edge-pixels or non-edge pixels based on the performance of the filter, and pixels which are not separated by an edge are placed into the same category. Edge based image segmentation is based on the assumption that an extreme of the first order derivative or a zero crossing in the second order derivative gives the position of an edge. The pixels are labelled as an object pixel based exclusively on its Gray value, regardless of the frame of reference. Component computation and segmentation can be replicated to maximize the results before the method converges into a coherent outcome.

4. Region-Dependent Approach: Region-dependent segmentation methods function iteratively by grouping neighboring pixels together and providing identical values and separating pixel categories that are unidentical in value. Spatial clustering can be known as segmentation. Clustering in the sense of clustering together pixels with similar values while the spatial component often forms a single related component in that pixel in the same category.

5. CNN Algorithm: Convolution layers play the role of extractor of characteristics. Convolution filter kernel weight parameters are determined as part of the training phase. Deep convolutional layers are capable of extracting local characteristics because they limit the hidden layers' receptive fields to being local. In CNNs, during the training phase, the weights of the convolutional layer used for the extraction of functions and the fully linked layer used for classification are measured. For training with balanced categories, we can apply the neural network algorithm and then refine it with proportions close the initial binary CNN to classify the full tumor.

6. Calculate Region of Interest: The detected region of tumor is shown after k-means clustering algorithm is applied on the image. The highlighted ROI is then analyzed to find area of tumor.

5. Algorithms and Sequence

A. Algorithms

Majorly three algorithms are used in the proposed system:

I. The Convolution Neural Network Algorithm

Convolution Neural Networks (CNNs) in recent times has been shown to be an efficient class of models for understanding image information, providing state-of-the-art image recognition, segmentation, identification, and recovery outcomes. System for video summarization that uses extracted Video

Frames for pre-processing. These featured frames are thereafter analyzed via Convolutional Neural Networks (CNN). Using this analysis, features are extracted and calculated, which are used for generation of summarized videos. As well as multiple hidden layers, a CNN consists of an input and an output layer. Convolutional layers, pooling layers, completely linked layers and normalization layers are usually the hidden layers of a CNN. CNN will be used to

train the data analytics engine for recognizing disease from the image.

II. Binarization and line segmentation Sauvola algorithm

Sauvola Algorithm is a thresholding technique algorithm where thresholds are local this technique gives very good results when the background of the image is non-uniform.

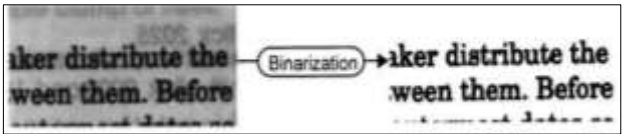

Fig 2: Example of Image Binarization

III. Image Thresholding algorithm

Choosing an intensity value as a threshold level is the easiest execution of the threshold, and the 0 (black) is the value for pixels below this threshold (black) and 1 (white) is the value of pixels above this threshold. If T is the f (x, y) global image threshold and g (x, y) is the threshold image, then:

$$g(x,y)=\begin{cases}1, & if \quad f(x,y)\geq T\\ 0, & otherwise\end{cases}$$

Fig 3: Image Thresholding Rule

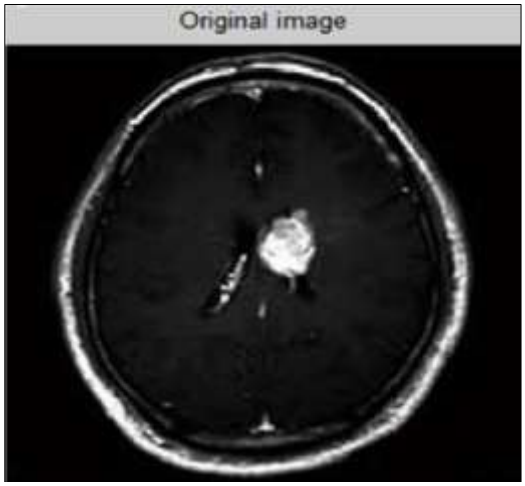

Fig 4: Image before Thresholding

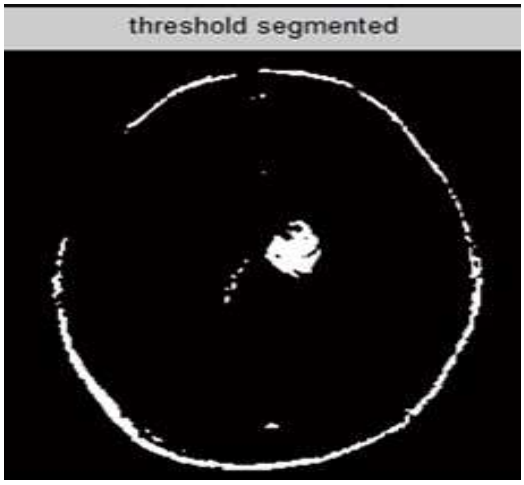

Fig 5: Image after Thresholding

B. Sequence

A sequence diagram is an engagement diagram that shows how, and in what order, processes work with each other. The sequence diagram illustrates the relationship between the admin, the system, and the database for the proposed system.

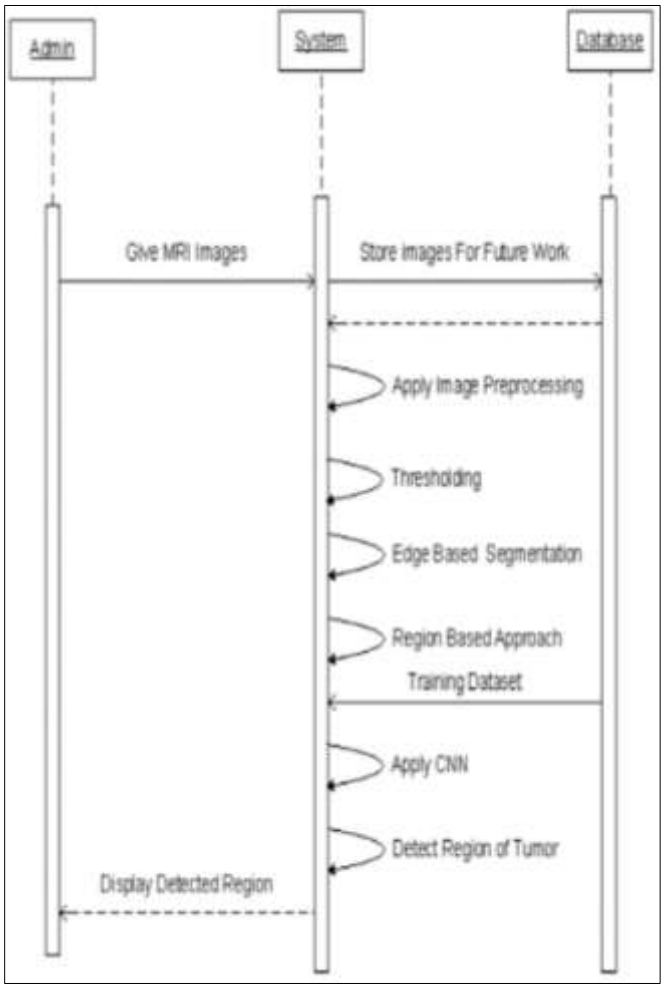

Fig 6: Sequence Diagram

6. Proposed Methodology

The model of our system works as a client-server software. The software will take MR image as input and will provide a detailed result obtained from the MRI.

The user will have to provide his basic details like Name, sex, age, email address and a MRI for using this system. The system will give an output consisting of lesion and supposed condition of the tumor.

7. Advantages

i. The system will reduce the workload of a radiologist.
ii. Accuracy is higher than existing systems.
iii. 24/7 Availability
iv. User-Friendly
v. Cost-Effective

8. Disadvantages

i. Server should be robust.
ii. User should still consult a doctor and not rely on the output of the system.
iii. Requires Timely Maintenance.

9. Future Scope

i. In future with improved algorithms more accuracy can be achieved in the results of detecting the tumors' size and stage of the cancer.
ii. This system can also be extended into finding other organ related diseases.
iii. In future with more data available this system can be helpful for animals as well.

10. Conclusion

Here for the identification of brain tumor from MRI brain images by performing various operations such as Edge Detection, Thresholding followed by segmentation, an algorithm such as CNN-based segmentation methods were built here. Here, we use two forms of segmentation techniques, segmenting or partitioning the captured image into several segments of pixels, such as edge-based segmentation and region-based segmentation. By applying the neural network algorithm to train balanced classes and then optimizing it to classify the full tumor with proportions near the initial binary CNN.

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