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A Comparative Study of Various Brain Tumor Detection Algorithms

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Abstract

In recent years, medical image researches for brain tumor detection are attaining more curiosity since the augmented need for efficient and objective evaluation of large amounts of data. Medically, tumors are also known as neoplasms, which are an abnormal mass of tissue resulting from uncontrolled proliferation or division of cells happening in the human body. If such growth is located within the brain, then it is called as brain tumor. Numerous researchers have made the noteworthy survey of the field of medical imaging and soft computing for brain tumor classification. This paper congregates representative works that demonstrate how artificial intelligence (AI) is applied and, which are used frequently to classify the brain tumor images from the normal brain images.

Keywords: survey on brain tumor, classification, artificial intelligence, medical imaging

Introduction

The dawn of medical imaging modalities such as X-ray ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI) has significantly enhanced the diagnosis of human diseases as they offer an efficient means for noninvasively mapping the structure of a subject. Previously, the universal method to investigate imaging data was visual inspection on printed support. Among these for Brain Imaging the MRI (Magnetic Resonance Imaging) is a mainly promising tool due to its soft-tissue contrast and non-invasiveness. MRI exploits radio waves and a burly magnetic field rather than X-rays to offer remarkably clear and exhaustive picture of internal organs and tissues clusters [1].

Brain tumor is any mass that results from an abnormal and an uncontrolled growth of cells in the brain. Its threat level depended on a group of features such as the type of tumor, its location, its size and its state of development [2]. A tumor can cause to injure by rising pressure inside the brain, by shifting the brain or pushing against the skull, and by invading and damaging nerves and healthy brain tissue. The position of a brain tumor influences the type of symptoms that arise. This is because different functions are controlled by different parts of the brain. Brain tumors infrequently spread to other parts of the body outer of the central nervous system (CNS) [3].

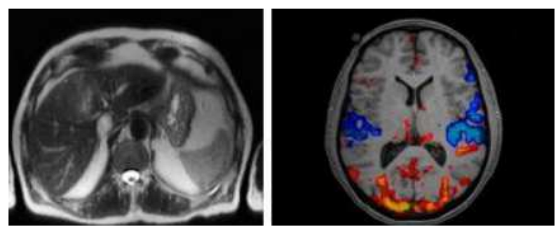

Fig1. Sample MRI Brain Images

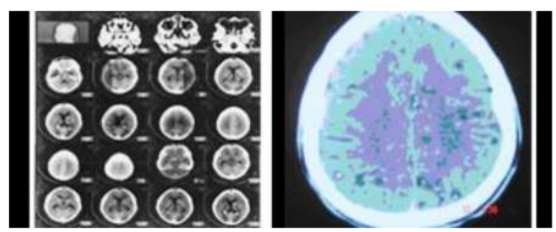

Fig2. Sample CT-Scan Brain Images

Image segmentation [4] is the progress of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The main objective of segmentation is to simplify and/or modify the representation as an image into something that is more significant and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. Furthermore, image segmentation is the process of assigning a label to each pixel within an image such as that pixels with the same label distribute certain visual characteristics.

In case of medical image segmentation the objective is to:

- ✓ Learn anatomical structure

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- ✓ Recognize Region of Interest (ROI) i.e. locate tumor, lesion and other deviations
- ✓ Measure tissue volume to evaluate growth of tumor (also decrease in size of tumor with treatment)
- ✓ Help in treatment planning earlier to radiation therapy; in radiation dose computation

Using segmentation in medical images is an awfully significant task for detecting the abnormalities, study and tracking progress of diseases and surgery planning. This paper analyzes the State-of-art techniques utilized in the classification of brain tumor images. It also compares the classification algorithms with the results concluded in the papers.

Algorithms for Detecting Brain Tumor

A novel method [7] for segmentation of brain tissues in MRI (magnetic resonance imaging) images is proposed in 2006. Initially, the author reduces noise using a versatile wavelet-based filter. Subsequently, the watershed algorithm was applied to brain tissues as an initial segmenting method. Normally, the result of the classical watershed algorithm on grey-scale textured image such as tissue images was over-segmentation. This method was an integration process of over-segmentation regions using fuzzy clustering algorithm (fuzzy C-means). However, there were some regions, which not separated absolutely, mainly in the transitional regions of gray matter and white matter, or cerebrospinal fluid and gray matter.

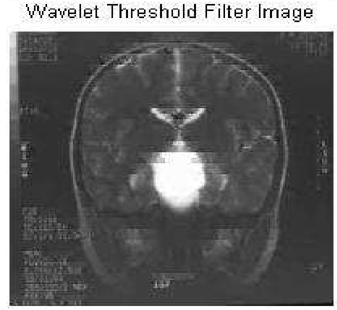
This provoked the construction of a re-segmentation approach to partition these regions. The authors in [7] browbeaten a technique using minimum covariance determinant (MCD) estimator to detect the regions needed segmentation again, and then partition them by a supervised k-nearest neighbor (kNN) classifier. This incorporated method yields a robust and precise segmentation. The effectiveness of their proposed algorithm was confirmed using extensive experiments. In [6], the Koley, S and Majumder have presented the segmentation of brain MRI for the purpose of determining the exact location of brain tumor using CSM based partitional K means clustering algorithm. CSM has fascinated much consideration since it gives efficient result as a self merging algorithm compared to other merging processes and the effect of noise was also less and the probability of obtaining the exact location of tumor is more. This approach is much simpler and computationally less complex and computation time is very least.

In [5] the authors have described the segmentation techniques to detect brain tumor from two-dimensional MR images. In this work, a preprocessing algorithm has been applied on MR images of the brain to enhance the contrast. Subsequently, image segmentation methods e.g. edge-based method and pixel-based method has been applied. The edge-based segmentation significantly detects the tumor. This pixel-based segmentation method chooses the tumor from the pre-processed image as a clustering feature. A low computation characteristic has been sustained and resulted with a successful segmentation. Therefore, color-based K-means clustering segmentation on brain MR images for tumor detection has maintained efficiency.

In 2013, an efficient detection of the brain tumor region from cerebral image was done [8] using Fuzzy C-means clustering and histogram. The histogram equalization calculates the intensity values of the grey level images and decomposition of image are extracted using principle component analysis was used to reduce dimensionality of the wavelet co -efficient. The accurate results of the proposed Fuzzy C-means (FCM) clustering algorithm successfully extracted the tumor region from brain MRI brain images. The Fuzzy C-means algorithm was used because of its simplicity, and it is also preferred for faster clustering. Image segmentation is an important concern in medical image processing and finds extensive application in many fields. When this technique has utilized, centroid point can be located easy and offered an additional accurate and high resolution result. This detection technique was triumphant in detecting the tumor region extracted; thus this work can be extended for more abnormality condition in the brain. A comparative analysis of these state-of-art methods is presented in the table1.

Gaussion smoothing Image

Wavelet Threshold Filter Image



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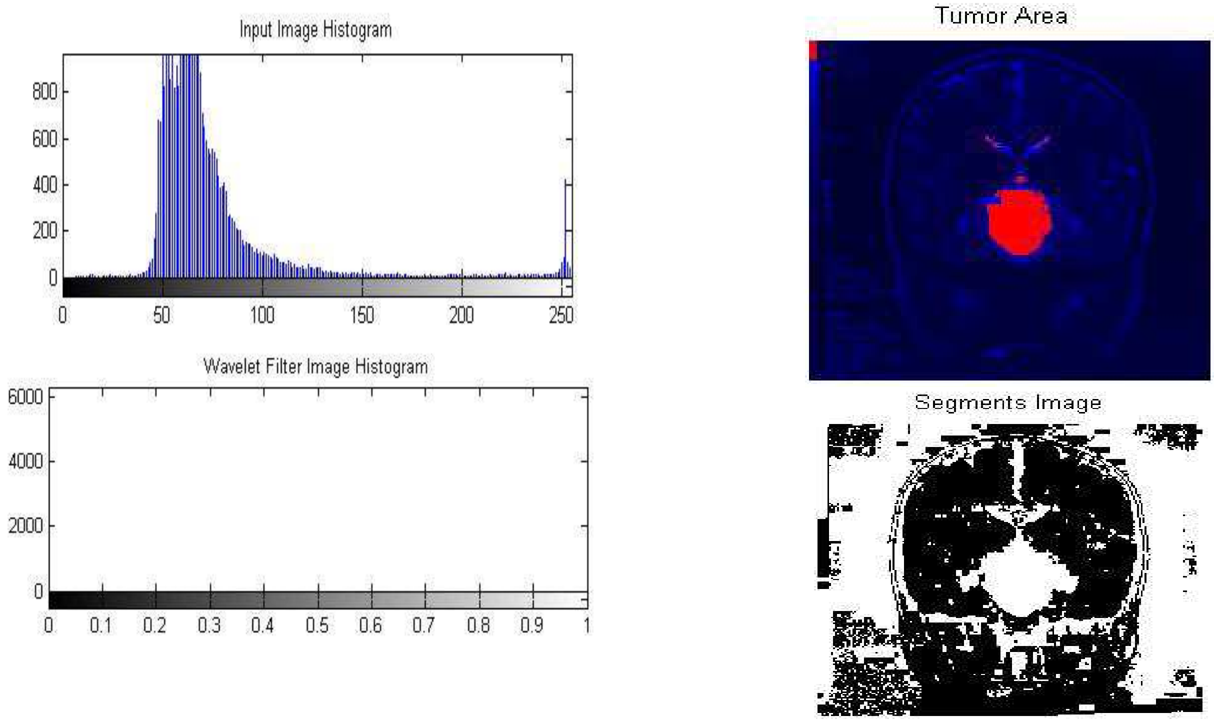

Fig.3 Various Stages of Brain Tumor Detection Algorithm (FCM)

Year	Algorithm	Advantages	Disadvantages
2013	Fuzzy C-means clustering algorithm	Gives best result for overlapped data set and comparatively better then k-means algorithm.	1. Apriori specification of the number of clusters. 2. Euclidean distance measures can unequally weight underlying factors.
2011	color based segmentation k-means clustering	It may produce tighter clusters than hierarchical clustering, especially if the clusters are globular.	Difficulty in comparing quality of the clusters produced (e.g. for different initial partitions or values of K affect outcome).
2011	Cohesion based self merging based partitional k-means algorithm	With a large number of variables, K-Means may be computationally faster than hierarchical clustering (if K is small).	Fixed number of clusters can make it difficult to predict what K should be.
2006	Re-segmentation process using KNN classifier	The K-Nearest Neighbor (KNN) Classifier is a very simple classifier that works well on basic recognition problems.	It is a lazy learner i.e. it does not learn anything from the training data and simply uses the training data itself for classification.

Conclusion

In this survey, various methods and techniques that are being used to detect the brain tumor from scanned MRI images of the brain are evaluated. A comparative study is made of various techniques. Image segmentation is a significant issue in digital image processing and finds extensive application in many fields. After review of well-known traditional techniques it is clearly revealed the various methods which can detect the tumor professionally and provide accurate results. Brain is scanned, that is, MRI image of the brain is acquired which is noise free. As in literature, many algorithms were employed to segment and detect the brain tumor images. Finally, a detailed comparison was presented and shown the efficiency of various algorithms.

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