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Review Article

Review on Recent Methods for Extraction of Clinical Information for Detection of Brain Tumor

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Abstract

The principal aim of brain MRI analysis is to extract clinical information that would improve diagnosis and treatment of disease. Obtaining clinical information requires detection and segmentation of normal and abnormal tissues. CAD systems can enhance diagnostic capabilities of physicians and reduce the time required for accurate diagnosis. The objective of this chapter is to review the published segmentation techniques and their state-of-the-art for the human brain MRI. The review of the literature reveals the CAD systems of human brain MRI images with their existing problems.

INTRODUCTION

Computer aided detection of brain tumors, stroke lesions, hemorrhage lesions, and multiple sclerosis lesions are the most difficult issues in the field of abnormal tissues segmentations because of many challenges. The brain injuries are of varied shapes and also distort other normal and healthy tissues structures. The intensity distribution of normal tissues is very complicated, and there exist some overlaps between different types of tissues. All the brain disorder segmentation methods use the dogma of the difference of the abnormal brain MRI from its normal counterpart. Over the last decade, various approaches have been proposed for the same. Some regarded the segmentation task a tissue recognition problem, which meant using a well-trained model that can determine whether a pixel belongs to a normal or abnormal tissue based on machine learning approach. Brain tumors are one of the most common brain diseases, so detection and segmentation of brain tumors in MRI are important in medical diagnosis. Existing methods leave significant room for increased automation, applicability and accuracy. In this chapter study of different existing methods for detection and segmentation of brain abnormalities (mostly tumors) in MR images.

REVIEW ON DIFFERENT METHODS FOR IMAGE SEGMENTATION

The threshold is one of the old procedures for image segmentation. These threshold techniques are very much useful for image binarization which is an essential task for any segmentation [1]. There are several threshold segmentation methods exist, among them here some well-known and well-established thresholding techniques such as Otsu method, Bernsen method, Sauvola method, Niblack method, Kapur method, and Th-mean method.

Otsu is a global thresholding method where threshold operation has been calculated by partitioning of the pixels of an image into two classes objects and background at gray level [2]. The threshold of an image has been computed by within-class variance and between-class variance then total variance. This algorithm does not work properly for all type MRI of the brain image, and this is because of large intensity variation of the foreground and background image intensity. Otsu method is not suitable for brain abnormality segmentation because it suffers from over segmentation and spurious lesions generations.

Bernsen's method that classifies an image of poor quality accurately, with the inhomogeneous paper background, is suitable for text shadow boundaries removal [3]. This method calculates the local threshold value based on the mean value of the minimum and maximum intensities of pixels within a window. This threshold works properly only when the contrast is large. Bernsen method generates a high threshold for brain MRI and produces better results than Otsu. But due to high threshold intensity, it suffers from under segmentation and generates normal tissues as abnormal tissues.

Niblack proposed an algorithm that computes a pixel-wise thresholding by shifting a rectangular window across the image [4]. This method varies the threshold over the image, based on the local mean and local standard deviation. It does not produce a good result for this type of image because of local threshold technique. This method is not a suitable for MRI of brain abnormalities segmentation because it suffers on the boundary region of the brain with a black background and abnormal tissues with normal tissues.

Sauvola and Pietikainen [5] method solves Niblack's [4] problem by hypothesizing on the gray values on an object and background pixels, resulting in the following formula for the threshold. The local mean and the standard deviation values of the local area denote the dynamics of the standard deviation fixed to 128. But Sauvola [5] is not suitable for MRI of brain image binarization. These methods produce poor results for MRI of brain image because of local thresholding selection on normal tissues. This method is not a suitable method for MRI of brain abnormalities segmentation

Kapur's algorithm [6] is an extension of Otsu's method by two probability distributions (e.g. object distributions and background distributions) from the original gray level distributions of the image. Kapur method is one of the best methods which produce a very good result of all type of MRI of brain image and MRI of brain abnormalities images. This method is very effective for MRI of brain till it suffers from under segmentation and spurious lesions generation.

Th-mean algorithms approach is the determining of thresholding of small region of the image, and the actual selection of threshold had done by mean of the all the thresholds [7]. This method not a suitable for MRI of brain tumor segmentation because of low threshold generation and it produces unnecessary noise within the brain during segmentation.

Some new thresholding based abnormalities techniques try to improve the lesion detection, but still, it fails due to diverse structural characteristics of brain MRI. A mean with standard deviation based method was proposed [8], but it suffers from incorrect segmentation. A modification of Otsu method was proposed [9] as initial states, but results of the method depend on the extra manual threshold intensity. Many MRI of brain suffers under and over estimation of abnormality from threshold based techniques.

CONCLUSIONS

A large number of approaches have been proposed by various researchers to deal with MRI images. The development of automatic and accurate CAD in characterizing brain lesions are essential and it remains an open problem. Lesion detection, segmentation or separation of a particular region of interest is an important process for diagnosis. Computer aided surgery also requires previous analysis of lesion area inside the brain. This process is a challenging process due to the complexity and large variations in the anatomical structures of human brain tissues, the variety of the possible shapes, locations and intensities of various types of lesions. Many methods need some preprocessing technique for improvement of accurate identification of brain abnormalities.

In the threshold intensity based binarized segmentation; Kapur method can provide better results than other for brain abnormalities segmentation. But Kapur thresholding suffers from under segmentation and spurious lesion generations for many brain images. Most of the binarized fail due to large intensity difference of foreground and background i.e. the black background of MRI image. In region growing methodologies are not standard methods for validating segmentation; the main problem is the quality of segmentation in the border of the tumor. These methods are suitable for the homogeneous tumor but not for heterogeneous tumor.

Classification based segmentation can segment tumor accurately and produce good results for large data set, but undesirable behaviors can occur in a case where a class is under-represented in training data. Clustered based segmentation performs very simple, fast and produces good results for the non-noise image but for noise images, it leads to serious inaccuracy in the segmentation. In a neural network-based segmentation perform little better on noise field and no need of assumption of any original data allocation, but the learning process is one of the great disadvantages of it. In spite of several difficulties, an atomization of brain tumor segmentation using a combination of a threshold based, preprocessing and the level set can overcome the problems and gives efficient and accurate results for brain abnormality detection. Accurate detection is the basis for calculating important features of brain lesion such as size, classification, heterogeneity, and volume of the lesions. The following existing problems are selected from the literature study:

I. The problems for small abnormality detection, under Segmentation, over-segmentation, spurious lesion generation, segmentation two or more abnormality in a brain, false identification, and segmenting abnormality with in homogeneity during abnormality segmentation.

II. The subcortical gray matter is underestimated, a cortical gray matter is overestimated, over and under-segmentation of normal brain tissue and non-brain part are performed by the existing tissues segmentation methodology.

III. Increased number of structures in the segmentation problem also increases the problem's mathematical complexity and a likelihood of misclassified pixels during abnormal and normal tissues segmentation.

To accurate detection, solve and reduce the existing problems of abnormalities identification from MRI of a brain, there are several steps that need to be done. Thus proposed framework decomposed into several sub work to correctly identification of abnormality and normal tissues of the brain. From the mentioned problem statements discussed in summary of this chapter, the specific objectives of this research are as follows:

i) Preprocessing stage: Artifacts removal and skull elimination are used to reduce the spurious lesion generation and false detection problem. ii) Binarization stage: Binarization can be used as an intermediate/preprocessing step of small, multiple, and low intense (or similar intensity with normal tissues) abnormalities detection (e.g., small tumor, multiple sclerosis). iii) Tissue detection and segmentation: Quantification of normal brain tissues and presence abnormality (disease like a tumor, stroke, hemorrhage, and MS) are identified (if any).

A brain MRI is normal or abnormal that can be identified during this stage. This stage reduces over-segmentation, under-segmentation, false detection and misclassification problem of white matter, gray matter, Cerebrospinal fluid, marrow, and muscle skull. iv) Abnormality detection and segmentation: This stage used to accurate detection and quantification, overcome over and under-segmentation problem, reduce spurious lesion generation, reduce misclassified pixels during abnormal and normal tissues segmentation of brain abnormalities. v) Classification of brain tumor: This stage used to classify the five major brain tumors from brain MRI. The preprocessing steps are used to reduce noise and improve the classification accuracy.

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