Design and Development of Algorithms for Enhancement of Brain Tumor from Medical Images

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Abstract

*Medical image processing technology is evolving and have its roots in the past where the bony tissues and the bones can be easily viewed through many diagnostic equipment like computed tomography. Computed tomography also known as CT scan is an imaging technique that helps to get 3D-structure of any part of the body through multiple cross-sectional areas and help detect any abnormality. CT scan being non-invasive and simplest diagnostic method can help to detect abnormal tissue growth mainly which is of the cancerous cells in the brain. This abnormal tissue growth in the brain which can cease normal functions of the brain over a long period of time results to having brain tumour. Studying the tumour when detected is very tedious and becomes challenging and hence we have designed various algorithms in MATLAB that can make this job a bit easier and can help detect the level of threat that the patient is at and what kind of treatment and medications should one undergo***.**

Keywords - *Computed tomography, Brain tumor, Algorithm, Image processing*

I. INTRODUCTION

Brain tumor being the deadliest disease need not just be cured completely but it's earliest detection can help to cease it and stop it from spreading more deeper into the tissues. Tumor can simply be defined as uncontrolled growth of tissues in any part of the body. Earlier there were no methods to detect this abnormal growth of tissues. Hence, this following research will help to detect and also define various parameters to enhance the tumor area and also determine its area and volume. It can be classified as benign and malignant. Benign tumors are non-cancerous tumors which are not deep-rooted in the tissue whereas malignant tumors are said to be cancerous tumors which grow quickly and spread to the neighbouring or nearly seated tissues and hence are proved to be life threatening. Tumor is classified as malignant with help of the segmentation process [22]. The brain is divided into four lobes and each lobe and area has specified own function as follow:
frontal lobe- tumor may contribute to poor reasoning, inappropriate social behaviour, and clogging. Temporal lobe- tumor may affect this lobe in a way that may contribute to poor memory, loss of hearing. Parietal lobe- tumor occurring here may result in poor interpretation of languages, poor visual perception, decrease sense of touch and pain. Occipital lobe- damage in this lobe may result in poor loss of vision [20]. For the earliest possible detection signal processing helps if used on various medical images. Signal processing on any image deals with some analysis, synthesis and modification of signals so as to obtain vital information about the structure and its tumor type. The earliest sign of brain tumor is: headache- which can be severe or pertinacious. Muscular difficulty in walking, instability, weak muscles and problem with coordination with the signals from brain. Whole body dizziness and fatigue. Gastrointestinal- vomiting or nausea, reduced sensation of touch. Cognitive- inability to speak or mental confusion [9] [16]. Medical imaging also helps to create anatomical, structural or functional images of the body and this will help the oncologist to study the type and the grade of the brain tumor that includes various parameters of the tumor like the size, volume and texture of region detected. Brain tumor is classified into four grades: grade I- the tissue associated is
benign. The cells look almost like normal brain cells and their grow is barely noticeable. Grade II- tissue is malignant. The cell looks less like normal cells compared to the cell in grade I tumor. Grade III- the malignant tissue has cell that look very different from that of normal cell. Abnormal cells are actively anaplastic. Grade IV- malignant tissue has cells that look most abnormal and tends to grow faster [5][8].

II. METHODOLOGY

Bio medical image processing techniques are used to detect tumor and has mainly the following steps:

- Image collection
- Pre-processing
- Image segmentation
- Feature extraction
- Tumor detection

A. Image collection

The acquisition of images directly from the console of CT-scan or MRI is important for precisely

detecting the tumor. Therefore, we have visited various hospitals that have provided us with various brain tumor images of different patients. We have tried collect images that have variations in its brain tumor pattern as it will help to apply the algorithms developed on large scale application. Some hospitals that provided images are:

- Shalby hospital, Ahmedabad
- Super scan imaging centre, Surat
- Mahavir hospital, Surat

Fig. 2.1.1 CT image of brain tumor

B. Pre-processing

Pre-processing is the most common name for operations with images at the lowest level of cogitation both input and output are images with intensity. These iconic images are as the same kind as the original data taken by the sensor, with intensity pixels usually represented by a matrices of image function value (brightness's). The aim of pre-processing is a step towards improvement of the image data that suppress unwanted distortions or enhances some required image features which are presumptuous for further processing, although geometric transformations of an image (e.g. rotation, scaling, or translation) is classified among pre-processing methods since similar techniques are used. Image pre-processing method are classified into four categories depending on the size of the pixel neighborhood which is used for the calculation of varied pixel brightness.

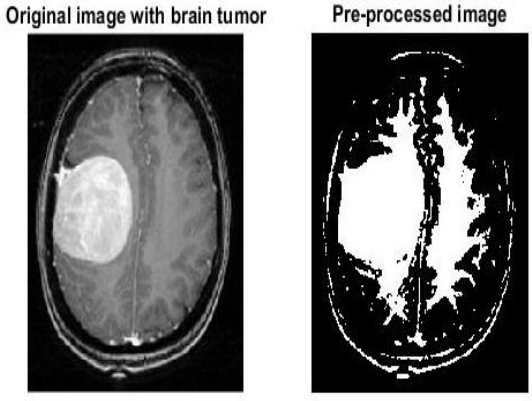


Fig 2.2.1 Output of Pre-processing

Four category of image pre-processing methods based on the size of pixel neighbourhood which are used for calculation of a new pixel:

- Pre-processing method that uses local neighbourhood of already processed pixel.
- Pixel brightness transformations
- Geometric transformations
- Image restoration techniques

C. Image segmentation

Image segmentation is primarily the process of partitioning any digital image into multiple segments (sets of pixels, that are also known as super-pixels). The main goal of segmentation is basically to simplify or change the overall representation of an image into something more meaningful and easier to analyse. Image segmentation is typically used to locate solid objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process which assigns label to every pixel in an image such that pixels with the same label commonly share certain similar characteristics.

There are various ways to classify the segmentation algorithm. One way to classify the algorithm is based on user interactions necessary for extracting the region of interest. Another way is to classify is based on the pixel relationship.

Based on user interactions, the segmentation algorithm can be classified into three categories: manual, semi-automatic and automatic. Boundary extraction is a subjective process and hence many variations are present among opinions of varied experts in the field, leading to problem in reproducing the same result each time whereas the manual method of extraction is more time consuming, also highly subjective, prone to minor human error, and has a poor intra-observer reproducibility. However, some manual methods are still commonly practised by experts to verify and validate the result of automatic segmentation algorithm.

Automatic segmentation algorithms are more preferred choice as this segment the structure of the object without any human intervention. They are preferred if the task needs to be carried out for large count of images. Semi-automatic algorithm is a combination of automatic and manual algorithm. In semi-automatic algorithm, human intervention is only required in its initial stages. Normally, the human observer is supposed to provide some initial seed point that indicates the region of interest. The extraction process is then carried out automatically as directed by the logic of segmentation algorithm. Another way of classifying the segmentation algorithm is to use the criteria of pixel matching relationship with neighbouring pixel. The similarity or matched relationship can be based on color, textures, brightness, or some other image statistics. Based on this, segmentation algorithm can be

classified as: contextual based (region) algorithms and non-contextual based (pixel) algorithms.
Contextual algorithm group pixels together based on common property by exploiting the relationship that exist among the pixel. These are also known as region-based or global algorithms. In region-based algorithm, the pixel is grouped based on some sort of similarity that is present between them. Non-contextual algorithm is also known as pixel based or local algorithm. These algorithms ignore the relationship that exist between the pixel and features. Instead, the basic idea of this is to identify the discreteness that is present in the image such as isolated lines and edges. This discreteness is then simply grouped as region based on some global level property.

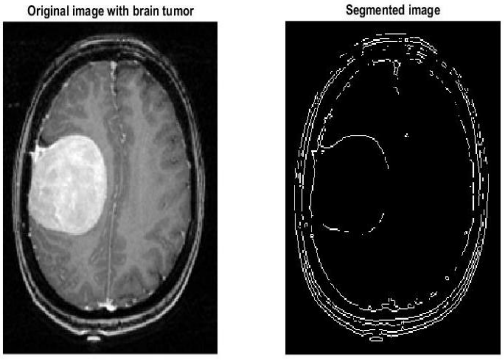


Fig 2.3.1 Output of Image Segmentation

D. Feature extraction

Feature extraction is a generalised term used for method of constructing various combinations of the variable to get around the problem while still describing the data with utmost accuracy.
Texture and varied gray scale value give spatial arrangement of different colour and intensity of numerical matrix, as active tumor and non-tumor parts have varied spatial arrangement though it may be fuzzy and overlapping various regions on the boundary, there are two possible approaches in distinguishing tumor part, either as structural arrangement or statistical quantitative metric. Both the approaches have broadly been used for detection of brain tumor. Size, volume and density are studied for using estimation model of growth and size of the detected tumor. It is an important factor that help to study as it helps to differentiate between malign tumor and benignant tumor.
Colour is a crucial feature required for detection of the tumor. Edge is also essential feature required and since the inherent nature of the brain tissues is such it not easy to find the sharp boundaries of the tumor, this nature and pixel arrangement of the edges is considered for detection of the brain tumor. Contrast values plays critical role in getting the real discriminant for tumor and non-tumor parts hence it is used major feature in some studies to get the accurate results in identification of tumor. Many researchers have used the descriptive statistics to take decision on tumor and non-tumor part and at the same time highly complex statistical feature combination have also been
used.

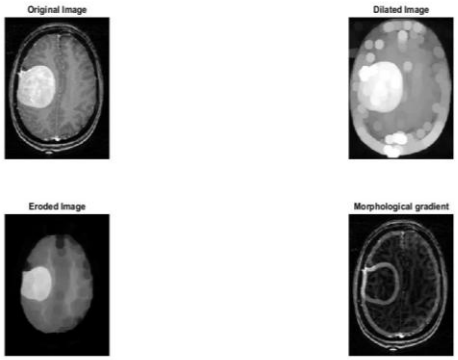


Fig 2.4.1 Output of feature extraction

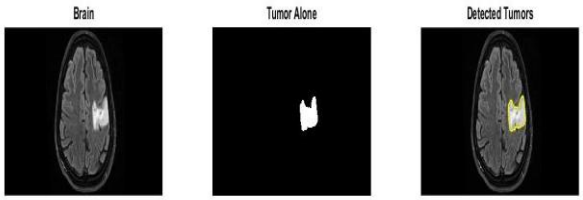
Morphological features identify shape and it is necessary to differentiate between kinds of tumors and to know its active growth model. Brain tumor occurs at the specific location and position, there were active tumor probability table made that help in tracing the location of the tumor, and various studies have been found. Inhomogeneity gives tumor part that becomes less uniform and less homogenous compared to part which does not have tumor even if it has some portions of white, grey and other fluids. Smoothness is one of the textures feature based method which help to discriminate smooth and non-smooth tissues for tumor detection.

E. Tumor detection

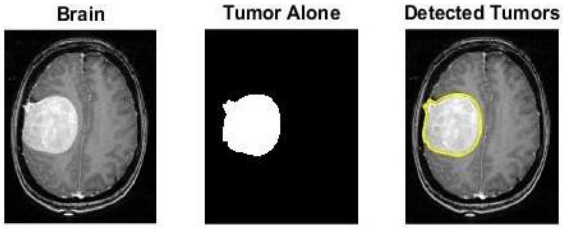
Detecting cancer is a multi-staged process. More often the patient will visit the doctor due to some symptoms or other. Sometimes cancer is discovered by chance or from screening some portions. The final cancer diagnosis is completely based on pathologist's opinion: cancer screening and cancer symptoms. In cancer screening mass screening for cancer focus only on specific cancers and their systematic detection in the early stage. Mass screening for cancer mainly aims to reduce mortality and reduce detected incidents of cancer. The brain cancer has numerous symptoms. It may be asymptomatic for a long duration of time or it may involve only with very general symptoms such as fatigue or weight loss. Cancer symptoms sometimes include bloody vomit, stool, urine, or a cough producing blood and pain, pale complexion, persistent coughing, prolonged sore throat, and change in bowel movement and urination. Cancer detection often involves radiological imaging, these images are often used to check the spreading of cancer inside the body or certain region and progress of treatment and to monitor it.

1. Test Cases

SUBJECT 1



SUBJECT 2



SUBJECT 3

SUBJECT 4

III. CONCLUSION

We have referred many reputed journals and conference papers and after this literature review we concluded and decided the methodology that will be best suited for the exact location and size of the tumor and hence help to detect the medication and treatment that need to be provided to the patient. Morphological operations have proved very helpful in extraction and segmentation of tumor. The resulting methods are very fast, robust and reliable for indexing tumor image for both archival and retrieval purposes and it can be used as vehicle for further clinical investigation. Above mentioned methodology is needful to detect the stage of the tumor and to predict the progression of brain tumor. The main goal is to improve local control, parts of multiple-disciplinary treatment, metronomic delivery. Medical imaging system with higher rate of reliability and preferences in brain imaging field to assist radiologist as well as neurosurgeons with less complexities. This leads to a different method with approximately similar results on brain tumor. Several methodologies are examined to denote the conventional stages of image processing also analyzed individual segmentation approach.

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