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AUTOMATED BRAIN TUMOR DETECTION AND IDENTIFICATION USING MEDICAL IMAGING

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Abstract: - Medical image processing is the demanding task and emerging field. Medical imaging procedure will view the images that are present in internal portions of the human body for medical analysis. Automatic Brain tumor segmentation is a perceptive stage in medical field. Tumor detection in medical imaging can be accurately detected by radiologist how a great knowledge and experience. In the MR images, the tumor part can be seen clearly by the accurate size and the correct measurement for the treatment. A necrotic part is known as neoplasm is a growth in the abnormal tissue that can be differentiated from the surrounding tissue. Segmentation algorithm that will segment brain MR images into tumor, white matter, gray matter and cerebrospinal fluid separately. In this paper, improved automatic image segmentation techniques were applied on MRI scan images in order to detect brain tumors. In this paper we describe the detection of the brain tumor by segmentation and extraction with help of pixel intensity. The proposed process consists of subsequent stages smoothing, non-maximum suppression, detection of region of interest (ROI) through thresholding .The tumor part is not alone identified the tumor can be spreaded to those region that can is also identified .The proposed technique can be proficiently applied, so that the doctor can prevent the spread of the tumor obtained from the MRI imagery from patient’s record.

Keywords: automatic image segmentation, cerebrospinal fluid, gray matter, Magnetic Resonance Imaging, region of interest and white matter.

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1. Introduction

The American cancer society estimated that 18,500 people would be diagnosed with brain tumor and those 12,760 men and women would die of brain cancer in 2005.The National Cancer Institute (NCI) estimated that 22,070 new cases of brain and central nervous system (CNS) cancers would be diagnosed. The American Brain Tumor Association (ABTA) estimating that 62,930 new cases of primary brain tumors would be diagnosed in

2010. By the year 2030, there will be 26 million new cases, and the death toll will reach to around 1.8 million people. According to World Health Organization (WHO), there are more than 120 types of brain tumors.

The brain is a soft, delicate, non-replaceable and spongy mass of tissue. Brain is considered as a kernel part of the body and has a very complex structure. The brain consists of two types of tissues: gray matter (GM) and white matter (WM) and also contains a cerebrospinal fluid (CSF) that consists of enzymes, glucose, salts, and white blood cells. The brain is divided into three major parts, the hind brain, the mid brain, and fore brain. The body is made up of many cells which have their own special function. Most of the cells in the body grow and divide to form a new cell of the same kind as they are needed for the proper operation of the human body. When these cells lose control and grow in an uncontrollable way. It gives rise to a mass of unwanted tissue forming a tumor.

Brain tumor is a group of abnormal cells that grows either inside the brain or around the brain. Tumor can directly destroy the healthy brain cells present in it but cause inflammation, brain swelling and pressure within the skull. The "tumor" is of Latin origin and means swelling. Symptoms vary depending on the size and location of tumor i.e. Headache, vomiting (usually in the morning), Nausea, Personality changes, Irritability, Drowsiness, Depression, Decreased cardiac and respiratory function and, eventually, coma if not treated.

A brain tumor is an intracranial solid neoplasm. Tumors can be classified into three types: 1) benign 2) pre malignant 3) malignant tumor. Benign tumors are those which are incapable of abrupt expanding and affecting the other healthy brain tissues. Premalignant tumor is a pre cancerous stage, if not treated properly it may lead to cancers. It is often considered as a disease. Malignant tumor grows rapidly with time an ultimately leads to death of patient. Malignant is a medical term describing a sever growth of a disease. The most common primary brain Tumors are gliomas, wherein 70% are in the group of malignant gliomas, glioblastoma multiform (GBM).The GBM is one of the highest malignant human neoplasms.

Imaging plays a central role in the diagnosis of brain tumors. Early imaging methods—invasive and sometimes dangerous such as pneumo encephalography and cerebral angiography have been abandoned in recent times in favor of non-invasive, high-resolution techniques, especially magnetic resonance imaging (MRI) and computed tomography (CT) - scans. Neoplasms will often show as differently colored masses in CT or MRI results. Radiologists examine the patient physically by using CT scan and MRI. MRI images showed the brain structures, tumor's size and location. From the MRI images the information such as tumors location provided radiologists, an easy way to diagnose the tumor and plan the surgical approach for its removal

In this paper the MRI scanned image is taken for the entire process. The MRI scan is more comfortable as compared to CT scan for diagnosis. It does not affect the human body as it doesn't use any radiation. It is based on the magnetic field and radio waves.MRI is excellent for showing abnormalities of the brain such as: stroke, hemorrhage, tumor, multiple sclerosis or lesions. Medical image analysis typically involves heterogeneous data that has been sampled from different underlying anatomic and pathologic physical processes. The heterogeneous processes in study are the tumor itself, comprising a necrotic (dead) part and an active part, the edema or swelling in the nearby brain, and the brain tissue itself.MRI is the state-of the-art medical imaging technology which allows cross sectional view of the body with unprecedented tissue contrast. MRI has the added advantage of being able to produce images which slice through the brain in both horizontal and vertical planes. This makes the MRI-scan images an ideal source for detecting; identifying and classifying the right infected regions of the brain.

Most of the current conventional diagnosis techniques are based on human experience in interpreting the MRI-scan for judgment; certainly this increases the possibility to false detection and identification of the brain tumor. On the other hand, applying digital image processing ensures the quick and precise detection of the tumor. One of the most effective techniques to extract information from complex medical images that has wide application in medical field is the segmentation process. The main objective of the image segmentation is to partition an image into mutually exclusive and exhausted regions such that each region of interest is spatially contiguous and the pixels within the region are homogeneous with respect to a predefined criterion.

Brain tumor segmentation in MR images has been recent area of research in the field of automated medical diagnosis as the death rate is higher among humans due to brain tumor. Image segmentation is typically used to locate objects and boundaries in images. The result of image segmentation is a set of regions that collectively cover the entire image, or a set of contours extracted from the image. On those images, brain tumours appear either hypointense (darker than brain tissue), or isointense (same intensity as brain tissue), or hyperintense (brighter than brain tissue).The various image processing techniques used for segmenting the brain can be divided into several groups: those required to perform a double threshold-based extraction of the brain, followed by refinement of brain contours.

The MRI images may contain some noise and sometimes text too. So there is a need in pre-processing these images to enhance them. The image processing algorithms for enhancement such as histogram equalization are used. To extract the tumor region the skull border of the MRI is removed. In recent years the development in medical science & imaging techniques given facility to use these techniques in various domains of medicine like surgical planning, time series and statistical analysis, computer aided pathologies, surgical guidance diagnosis.

2. Proposed Approach

A. Image acquisition

In our proposed approach we first considered that the MRI scan images of a given patient are either color, Gray-scale or intensity images herein are displayed with a default size of 220×220. If it is color image, a Gray-scale converted image is defined by using a large matrix whose entries are numerical values between 0 and 255, where 0 corresponds to black and 255 to white for instance. Then the brain tumor detection of a given patient consist of two main stages namely, image segmentation and edge detection.

B. Image segmentation

The image segmentation is to cluster pixels into prominent image region. Segmentation of Gray level images is used to provide information such as anatomical structure and identifying the Region of Interest i.e. locate tumor, lesion and other abnormalities. The proposed approach is based on the information of anatomical structure of the healthy parts and compares it with the infected parts. Then it locates the abnormal parts in the unhealthy patient brain scan image by comparing it with the reference image information.

1) *Smoothing*: There are different types of noise encountered by different techniques, depending on the noise nature and characteristics, namely Gaussian noise and impulse noise. Smoothing, also called blurring. There are many reasons for smoothing. Here smoothing is used in order to reduce noise .To perform a smoothing operation we will apply a filter to our image. The most common type of filters is linear, in which an output pixel's value (i.e.$g(i,j)$) is determined as a weighted sum of input pixel values (i.e.$f(i+k,j+l)$):

$$g(i,j) = \sum_{k,l} f(i+k, j+l)h(k,l)$$

$h(k,l)$Is called the kernel, which is nothing more than the coefficients of the filter. It helps to visualize a filter as a window of coefficients sliding across the image. The proposed noise enhancement algorithm is based on using Gaussian filters and includes the Smoothing filters that are used to reduce or remove Gaussian noise from the MRI image. Sharpening filters that are used for highlighting edges in an image, and are based on the use of first and second order derivatives.

2) *Smoothing using Gaussian filter:* Gaussian filter, probably the most useful filter. Gaussian filtering is done by convolving each point in the input array with a Gaussian kernel and then summing them all to produce the output array. Assuming that an image is 1D, you can notice that the pixel located in the middle would have the biggest weight. The weight of its neighbours decreases as the spatial distance between them and the centre pixel increases. A 2D Gaussian can be represented as

$$G_0(x,y) = Ae^{\frac{-(x-\mu_x)^2}{2\sigma_x^2} + \frac{-(y-\mu_y)^2}{2\sigma_y^2}}$$

Where μ is the mean (the peak) and σ represents the variance (per each of the variables x and y).However this type of filters enhanced the noise reduction level compared with the linear filters,

C. Edge detection

An edge is a property attached to an individual pixel and is calculated from the image function behaviour in a neighbourhood of the pixel. The purpose of edge detection in general is to significantly reduce the amount of data in an image, while preserving the structural properties. In this paper, other than filtering the region of interest (ROI) is proposed to identify different tumor types. It also introduced to enhance the processing time by executing the features processing algorithm in the identified areas instead of the whole image frame. In this research, we first applied a vector subtraction algorithm then the ROI is determined by finding the related adjacent portions in the resultant image from the vector subtraction. The area of each related adjacent portion is computed and the irrelevant portions removed resulting in the desired tumor region. We successfully implemented Canny's mathematical formulas to increase the performance of the proposed edge detection algorithm. Even though it is quite old, it has become one of the standard edge detection methods and it is still used in research.

D. Canny edge detection

The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. Canny also produced a *computational theory of edge detection*. The Process of Canny edge detection algorithm can be broken down to 5 different steps:

1. Apply Gaussian filter to smooth the image in order to remove the noise
2. Find the intensity gradients of the image
3. Apply non-maximum suppression to get rid of spurious response to edge detection
4. Apply double threshold to determine potential edges
5. Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges.

While traditional canny edge detection provides relatively simple. The traditional algorithm can no longer handle the challenging edge detection task.

E. Improvement on Canny Edge Detection

1. *Smoothing:* Since all edge detection results are easily affected by image noise, it is essential to filter out the noise to prevent false detection caused by noise. Blurring of the image to remove noise. To smooth the image, a Gaussian filter is applied to convolve with the image. Our proposed method uses 5×5 Gaussian template and the original image to weight neighbourhood. This step will slightly smooth the image to reduce the effects of obvious noise on the edge detector. The equation for a Gaussian filter kernel of size (2*k*+1) × (2*k*+1) is given by:

$$H_{ij} = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{(i-k-1)^2+(j-k-1)^2}{2\sigma^2}\right)$$

It is important to understand that the selection of the size of the Gaussian kernel will affect the performance of the detector. The larger the size is, the lower the detector's sensitivity to noise. Additionally, the localization error to detect the edge will slightly increase with the increase of the Gaussian filter kernel size. A 5×5 is a good size for most cases, but this will also vary depending on specific situations.

2. *Finding gradients:* The edges should be marked where the gradients of the image has large magnitudes. Instead of using a 2*2 neighbourhood window to calculate the gradient magnitude values and directions, a 3*3 neighbourhood windows is used for better magnitude and direction value. The equations are demonstrated as

$$G_x(x,y) = [I(i,j+1)-I(i,j-1)+I(i-1,j+1)-I(i-1,j-1)+I(i+1,j+1)-I(i+1,j-1)]/2$$
$$G_y(x,y) = [I(i+1,j)-I(i-1,j)+I(i+1,j-1)-I(i-1,j-1)+I(i+1,j+1)-I(i-1,j+1)]/2$$

Where gx and gy are the gradients in the x- and y-directions respectively and represents the results of the original image filtered along rows and lines. Θ is the gradient direction. Proposed system uses Sobel Operator. The operator consists of a pair of 3×3 convolution kernels

$$|G| = \sqrt{Gx^2 + Gy^2}$$

The angle of orientation of the edge

$$\theta = \arctan(Gy/Gx)$$

3. Non-maximum suppression: Non-maximum suppression is an edge thinning technique. It is applied to "thin" the edge. After applying gradient calculation, the edge extracted from the gradient value is still quite

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blurred. Thus non-maximum suppression can help to suppress all the gradient values to 0 except the local maximal, a) Compare the edge strength of the current pixel with the edge strength of the pixel in the positive and negative gradient directions.

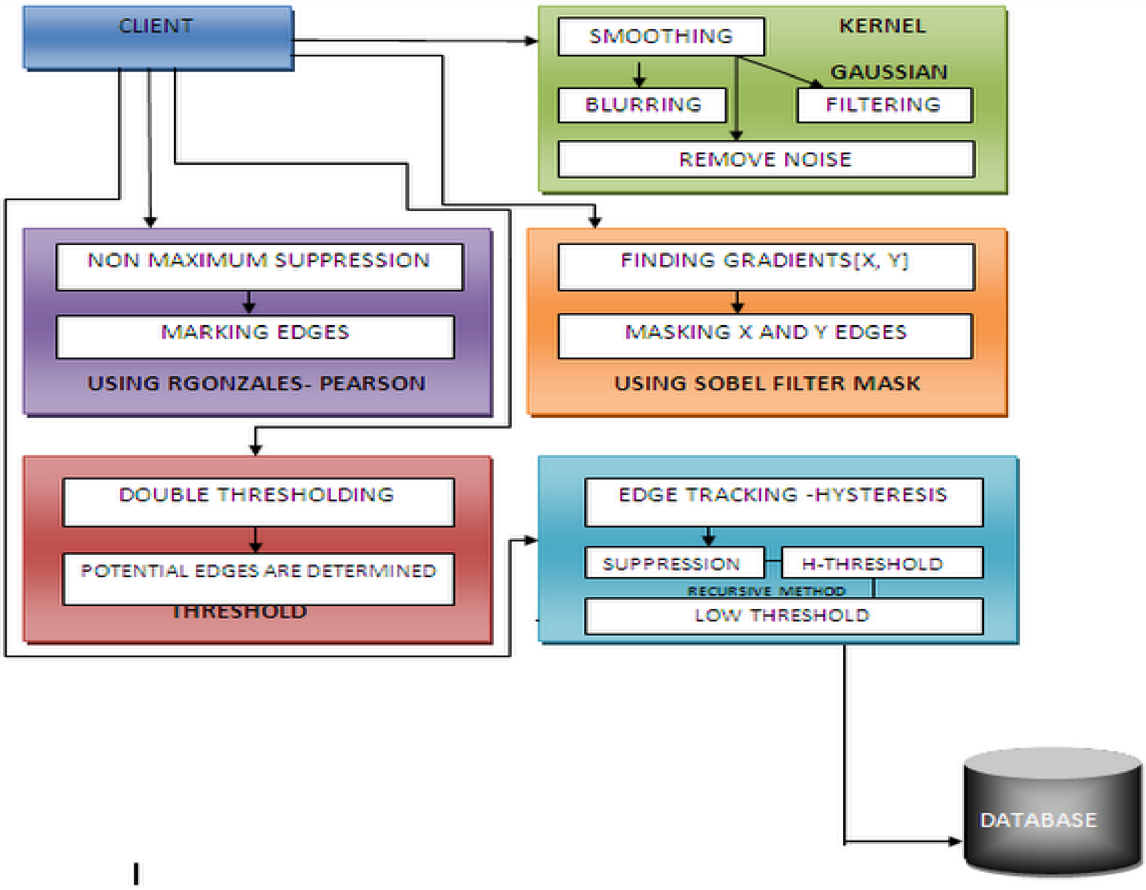
b) If the edge strength of the current pixel is the largest compared to the other pixels in the mask with the same direction the value will be preserved. Otherwise, the value will be suppressed.

4. Double thresholding: Potential edges are determined by thresholding. Edge pixels stronger than the high threshold are marked as strong; edge pixels weaker than the low threshold are suppressed and edge pixels between the two thresholds are marked as weak.

5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain strong edge. Weak edges are included if and only if they are connected to strong edges. The logic is of course that noise and other small variations are unlikely to result in a strong edge. Thus strong edges will only be due to true edges in the original image. The weak edges can either be due to true edges or noise/color variations. Weak edges due to true edges are much more likely to be connected directly to strong edges. In this paper edge detection is implemented adaptive method to determine the threshold value for different images. It put all the pixel values in the image into two group's c0 and c1, which is separated by an unknown threshold value *T*. The corresponding pixel number of intensity level *i* is noted as, thus the probability is defined as

$$p_i = \frac{n_i}{n}$$

Where n is the total number of the pixel points in the image



3. EXPERIMENTAL RESULTS

The proposed method was tested for several slices of brain MRI images. The area of the detected tumor has been calculated for each slice.

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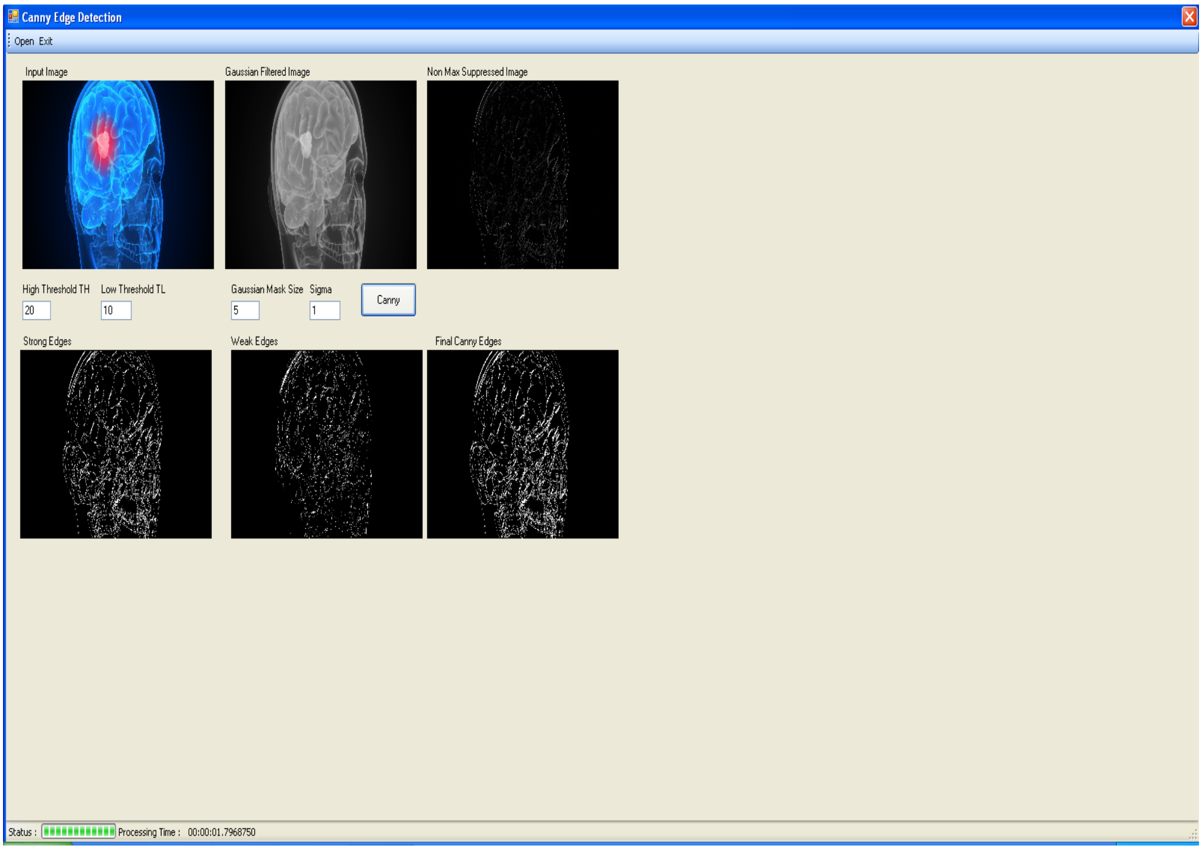

4. CONCLUSION

In this paper, we proposed an approach for Brain tumor detection, identification and classification. it based on an integrated set of image processing algorithms i.e. modified Canny edge detection algorithm simulation results using this algorithm showed its ability to accurately detect and identify the contour of the tumor, its computational time and accuracy were much less than its corresponding algorithms. In this Project, the tumor part is detected with the help of the MRI and the tumor can be spreaded by affecting the healthy tissues of the brain. So the proposed approach is used to detect the tumor spread position. It helps the doctor to identify the tumor spread and can prevent the spread of the tumor

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