

MRI Brain Image Enhancement Using Filtering Techniques

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Abstract- Magnetic Resonance Image is one of the best technologies currently being used for diagnosing brain cancer at advanced stages. This paper proposes a novel approach for the MRI image enhancement, which is based on the Modified Tracking Algorithm, Histogram Equalization and Center Weighted Median (CWM) filter. This method consists of two approaches. The first approach is applying the modified tracking algorithm to remove the film artifacts, labels and skull region and then applying the Histogram Equalization and Center Weighted Median (CWM) filter techniques separately to enhance the images.

Keywords- Magnetic Resonance Image (MRI) Brain Tumor; Image enhancement; Modified Tracking Algorithm; Histogram Equalization; Center Weighted Median (CWM)Filter

I. INTRODUCTION

Brain tumor is one of the major causes for the increase in Mortality among people. A tumor is an abnormal growth caused by cells reproducing themselves in an uncontrolled manner. This year 2012, an estimated 22,910 adults (12,630 men and 10,280 women) in the United States will be diagnosed with primary malignant tumors of the brain and spinal cord. It is estimated that 13,700 adults (7,720 men and 5,980 women) will die from this disease this year. Brain tumors are the tenth most common cause of cancer death in women. About 4,000 children and teens will be diagnosed with a brain or central nervous system tumor this year. More than half of these are in children younger than 15. About 20% to 40% of patients with other types of cancer will have it spread to the brain. The most common primary cancers that spread to the brain are lung, breast, unknown primary, melanoma, and colon cancer [10].

The tumor is divided in to two categories: Primary brain tumor and secondary tumor. A primary malignant brain tumor is one that originates in the brain itself although these tumors often shed cancerous cells to other sites in the central nervous system and spread to other parts of the body. A secondary or metastatic brain tumor occurs when cancer cells spread to the brain from a primary cancer in another part of the body. Detection of brain tumor requires high-resolution brain MRI. Most Medical Imaging Studies and detection conducted using MRI, Positron Emission Tomography (PET) and Computed tomography (CT) Scan. Now a days MRI systems are very important in medical image analysis. The MRI image shows the clear distinction between the tissues, bones and fluid, so it makes easy to distinguish the tumor part from the image. In order to find the tumor part efficiently the MRI image should be enhanced properly.

Wide range of image processing techniques [1-5] has been developed for image enhancement, segmentation, restoration and classification. Image enhancement refers to emphasis, or sharpening, of image features such as edges, boundaries, or contrast to make a graphic display more useful for display and analysis. Image enhancement consists of gray level and contrast manipulation, noise reduction, edge crispening, and sharpening, filtering, interpolation and magnification[6-7]. For processing the MRI brain images the image should be preprocessed to remove the film artifacts, labels and the Skull regions. Many papers given in the literature [11-12] explains about the tracking algorithm. Weighted median (WM) filters are a the extension of median filters, which exploit not only rank-order information but also spatial information of input signal. Among WM filters, center weighted median (CWM) filters are very special because of its simplicity and perfectness. This is because, first, CWM filters are the simplest WM filters and the easiest to design and implement. Second, CWM filters are better understood theoretically.

This paper is organized as follows: section 2 presents image acquisition, section 3 presents preprocessing technique, section 4 presents histogram modeling for brain MRI images, section 5 presents the center weighted median filter, section 6 presents experiments and results techniques and the section 7 presents summary and conclusions.

II. IMAGE ACQUISITION

To access the real medical images for carrying out research is a very difficult due to heavy technical hurdles. The MRI data is obtained from the Brain Web Database at the McConnell Brain Imaging center of the Montreal Neurological Institute (MNI), McGillUniversity.(<http://www.bic.mni.mcgill.ca/brainweb>). A sample of 80 T1 weighted images are taken and used for enhancement purpose. T1- weighted images shows water darker and the fat brighter. An image of a patient obtained by MRI scan is displayed as an array of Pixels (a Two Dimensional unit based on the matrix size and the field of view) are stored. Images are three types (a) Binary Images (b) Gray Scale Image (c) Color Image. In this paper, we consider grayscale or Intensity Images to display an image with default size of 256 x 256. The following figure (3.1) displays a MRI Brain Image. A grayscale Image can be specified by giving a large matrix whose entries are numbers between 0 and 255, with 0 to black and 255 to white.

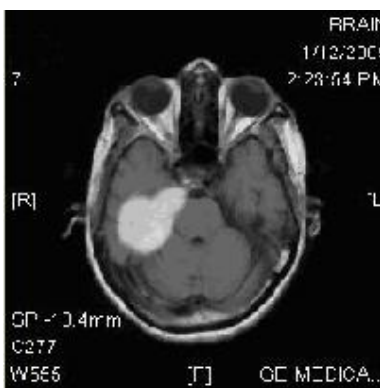


Figure 1. Acquired Brain MRI image

III. PREPROCESSING TECHNIQUES

A. Removal of film artifacts

This paper presents an integrated method of the adaptive enhancement of brain tissues in two-dimensional (2-D) MRI images. The MRI brain image consists of film artifacts or label on the MRI such as patient name, age and marks. film artifacts that are removed using tracking algorithm .Here, starting from the first row and first column, the intensity value of the pixels are analyzed and the threshold value of the film artifacts are found. The threshold value, greater than that of the threshold value is removed from MRI. The high intensity values of film artifacts are removed from MRI brain image. The following figures explain the process of preprocessing stage.

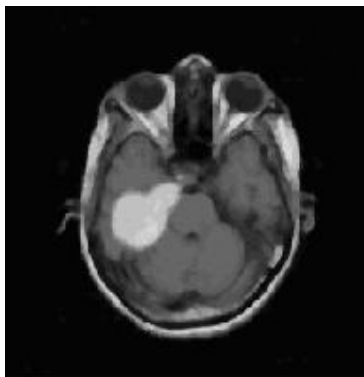


Figure 2. Removal of film artifacts

B. Removal of Skull using Modified Tracking Algorithm.

After removing the film artifacts another part of the MRI which is not required for our further processing is the skull. The modified Tracking Algorithm is used to remove unwanted portion of MRI that means left, right and top skull portions .The MRI image obtained after removing the film artifacts and labels is taken. Start from left side first row, first column of the given matrix and select the peak threshold value from left side of the matrix and assign flag value to 200. If the current pixel intensity value ranges from 200-255 then, the set the flag value to zero and thus the left skull Portion of the MRI is removed. Repeat these steps to remove the right and top skull portion of the MRI.

IV. HISTOGRAM MODELING

Intensity transformation functions based on information extracted from image intensity histograms vital role in image processing, in areas such as enhancement, compression, segmentation, and description. This section is on obtaining, plotting, and using histograms for image enhancement.

A. Image Histograms

The histogram of a digital image with L total possible intensity levels in the range $[0, G]$ is defined as the discrete function $h(r_k) = n_k$ where r_k is the k^{th} intensity level in the interval $[0, G]$ and n_k is the number of pixels in the image whose intensity level is r_k . Often, it is useful to work with normalized histograms, obtained simply by dividing all elements of $h(r_k)$ by the total number of pixels in the image, which denote by n : $p(r_k) = h(r_k) / n = n_k / n$ for $k = 1, 2, \dots, L$ from basic probability, recognize $p(r_k)$ as an element of the probability of occurrence of intensity level r_k .

B. Histogram Equalization

Let us consider for a moment that intensity levels are continuous quantities normalized to the range $[0, 1]$, and let $P_r(r)$ denote the probability density function (PDF) of the intensity levels in a given image, where the subscript is used for differentiating between the PDFs of the input and output images. Suppose perform the following transformation on the input levels to obtain output (processed) intensity levels, $s: s = T(r) = \int_0^r P_r(w) dw$ where w is a dummy variable of integration. It can be shown that the probability density function of the output levels is uniform; that is, $P_s(s) = 1$ for $0 \leq s \leq 1$; 0 otherwise.

V. CENTER WEIGHTED MEDIAN FILTER

In medical image processing, necessary to perform a high degree of noise reduction in an image before performing high-level processing steps. Median Filter can remove the noise, high frequency components from MRI without disturbing the edges and it is used to reduce 'salt and pepper' noise. This technique calculates the median of the surrounding pixels to determine the new (denoised) value of the pixel. A median is calculated by sorting all pixel values by their size, then selecting the median value as the new value for the pixel. The amount of pixels which should be used to calculate the median [8].

A weighted median filter controlled by evidence fusion is proposed for removing noise from MRI brain images with contrast. It has a great potential for being used in rank order filtering and image processing. The weights of the filter are set based on intensity value of the pixels in the MRI image. Here we used four weights such as 0, 0.1, 0.2 and 0.3. if the intensity value of the pixel is 0 then consider the weight of the pixel is 0. Else if the range of pixel intensity between 1-100 then the weight is 0.1, else if the range of pixel intensity between 101-200 then the weight is 0.2, otherwise the weight of the pixel is 0.3. the above weights are multiplied with pixel intensity. after that the median filter is applied for calculate weighted median filter.

The center weighted median (CWM) filter, which is a weighted median filter giving more weight only to the central value of each window, is used. This filter can preserve image details while suppressing additive white and/or impulsive-type noise. The statistical properties of the CWM filter are analyzed. It is shown that the CWM filter can outperform the median filter [13-16]. It is shown that the CWM filter is an excellent detail preserving smoother that can suppress signal-dependent noise as well as signal-independent noise [9].

In a CWM filter, the center sample is assigned a larger weight, i.e. $w(0, 0) = 2K + 1$

where $K \geq 0$, and all other non-zero weights are equal to one, i.e. $w(i, j) = 1$ for i not equal to 0 and j not equal to 0. K is a nonnegative integer.

A CWM filter is completely specified by two parameters, the window size and the center weight. The filtering behavior of a CWM filter will thus be controlled by these two parameters. Denote a CWM filter with center weight $2K + 1$ by $CWM(M; 2K + 1)$, where M is the number of the samples in the window, e.g., $M = (2N + 1) \times (2N + 1)$ for a connected square window.

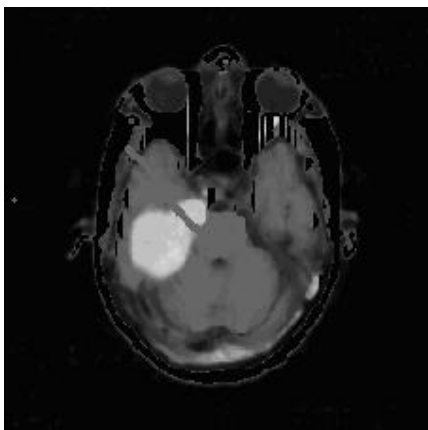


Figure 3. Enhanced MRI Brain image

VI. EXPERIMENTS AND RESULTS

This algorithm has been tested with various types of textured images acquired in the database. This proposed approach has been implemented by using mat lab. The experimental results are tested in Intel Pentium IV 2.4 GHz processor with 256 MB RAM. It is very difficult measure to the improvement of the enhancement objectively. If the enhanced image can make observer perceive the region of interest better, then we can say that the original image has been improved. In order to compare different enhancement algorithms, it is better to design some methods for the evaluation of enhancement objectively. The statistical measurements such as variance or entropy can always measure the local contrast enhancement; however that show no consistency for the MRI. Performance of the Median filter, Weighted Median filter, and center weighted median filters are analysed and evaluated. Table1 shows the performance of listed filters.

TABLE 1 PERFORMANCE ANALYSIS FILTERS

o	Sn	Filters	PSNR	ASNR
1		Median	0.91543	0.9267
2		Weighted Median	0.92667	0.9278
3		Center Weighted Median	0.92726	0.9280

VII. SUMMARY AND CONCLUSIONS

Our proposed method is based on a combination of different approaches to preprocess and enhance the brain MRI images. The gray level transformation, logarithmic transformation, histogram equalization and median filtering are presented. Initially the MRI brain image is acquired from MRI brain data set to MATLAB 7.1. After acquisition the MRI is given to the preprocessing stage, here the film artifacts (labels) are removed. next, the high frequency components and noise are removed from MRI using the following filters. Such as Median filter, Weighted Median filter and Center Weighted Median filter. The performance of above filters are measured and evaluated. Finally the best filter of center weighted median filter is identified and used for MR brain image enhancement. It is used for removing noise from MRI brain images with high contrast.

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