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Extraction and Enhancement of Cancer Cell from MRI Colorectal Image

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Abstract: ***Medical Image Processing is one of the most challenging and emerging topics in today's research field. Processing of Magnetic Resonance Imaging (MRI) is one of the major fields in this area. MRI consists of RF-Coils which helps us to receive signals from different body parts [1]. These coils are capable of receiving the signals to the frequency they are tuned to. The frequency will be set on analyzing the test process of RF coils which was preferred earlier, and now changing it to the improved process may lead to design changes or change in the method of testing process. In recent years, multispectral MRI has emerged as an alternative to Ultrasound (US) image modality for clear identification of cancer in colon, rectal, Breast, Prostate, Liver etc.,. In order to analyze a disease, Physicians consider MR imaging modality as the most efficient one for identification of cancer present in various organs. Therefore, analysis on MR imaging is required for efficient disease diagnosis. Hence extraction of colorectal cancer cells from patient's MRI scan image of the colon and rectal organs and enhancement of the output image to get the clear image of the cancer cells is required. This proposed method incorporates some tuning/matching, oscillation and sensitivity which are the basic steps in testing process of RF-Coils. Noise removal functions, segmentation and morphological function are considered to be the basic concepts of Image Processing. Image enhancement technology follows the hardware description language (Verilog). The use of HDL to provide signal processing results is a new technique replacing the classical simulations and offering a direct connection to hardware VLSI implementations. Detection and extraction of cancer cells from MRI colorectal image can be done by using the MATLAB software, and enhancement is done using Hardware description language, Verilog.***

Keywords: MRI, Image Enhancement, image modality, HDL, MATLAB.

1. Introduction

RF-Coils are main parts in reception of the stimulus generated from the human body tissues, which will leads to the formation of the clear cut image after doing some image processing steps. There are different types of RF-Coils available like PA-Coil, HNU-Coil, AA-Coil, Head-Coil, and flex Coil etc. [2]. These coils are used based on the region of interest. During the manufacturing process of these coils it's required to tune the coil to the particular frequency, for example a 63.86MHz frequency when operating at 1.5T Magnetic field [9], after tuning , some of the test process will be carried out which may effect to the tuned frequency, since variable capacitor is the device used to tune the frequency. As the property of the variable capacitor states that the value of capacitor may change due to the change in high voltage in the circuit, like ESD [2], high vibrations in the device and at times by short circuit. In this project we mainly concentrate on getting the possibly getting a better quality output from the RF-Coil by making changes in the testing process, which is done by analyzing the initial process and its overall output.

We are taking the output from the RF-Coil which is tuned by using the new testing process illustrated bellow. We majorly concentrate on Cancer which is defined as the abnormal growth of tissues. Colorectal cancer is a form of cancer that develops in the colon and rectal body parts, a gland in the male reproductive system. Most colorectal cancers are slow growing. These cancer cells may spread from the colon to other parts of the body; particularly, the lymph and nodes [3]. Rates of detection of Colon cancer vary widely across the world. The Colon cancer is the second leading cause of cancer-related death in the United States among men and is the most commonly diagnosed cancer. Magnetic Resonance Imaging (MRI) is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body. MRI imaging is often used when treating brain, colon cancers, ankle, and foot. From these high-resolution images, we can derive detailed, anatomical information to examine human organ development and discover abnormalities. Nowadays there are several methodology for classifying MR images, which are fuzzy methods, neural networks, atlas methods, knowledge based techniques, shape methods and variation segmentation [10].

MRI consists of T1 weighted, T2 weighted and PD (proton density) weighted images and are processed by a system which integrates fuzzy based technique with multispectral analysis [7]. Multispectral MRI dataset consists of images that represent the morphological and functional response of colon gland. Features are directly the pixel intensities of multispectral MR images. Colorectal MR Image consists of two regions of interest; Transition Zone (TZ), Peripheral Zone (PZ) [3], and only PZ region is considered because majority of the colon cancer occurs in PZ, the colorectal body part with different regions shown in figure 1.

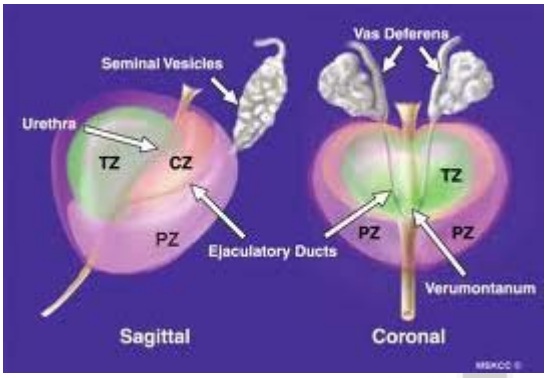

Figure 1, Colon and rectal body parts.

Image pre-processing is the term for operations on images at the lowest level of abstraction [5]. These operations do not increase image information content, but they decrease it if entropy is an information measure. The aim of pre-processing is an improvement of the image data that suppresses undesired distortions or enhances some image features relevant for further processing and analysis task.

Pre-processing of MRI images is the primary step in image analysis which perform image enhancement and noise reduction techniques which are used to enhance the image quality, then some morphological operations are applied to detect the cancer cells in the image.

Section I, Describes the process of getting the output from MRI RF-Coil after changes made in tuning/matching stages [12], this is to make the coil to operate at the desired frequency all the time.

Section II Describes the proposed methodology, in detail with preprocessing of colorectal MRI image using High Pass and Median Filtering, Thresholding and Watershed Segmentation methods for Segmentation of given image and computing some morphological operations to identify the cancer cells in given MRI colorectal image[6]. Section III Describes the enhancement of image to make some contrast, brightness and rotate operation on Image, which will be done using HDL (Hardware description language) [8].

2. MRI-RF Coil Tuning/Matching Process

Considering the MRI-coil the earlier method followed for tuning/matching [12], involves the following steps:

1. Removal of tabs connected to all the elements (14, 16), [5]-[7].
2. Connect the element for which tuning/matching has to be done.
3. Tune the operating range to desired frequency.
4. This process will be carried out for all the elements.

The coil may consist of coupling between one or more elements. These coupling elements are again mapped to the same desired frequency. At the end all the tabs are connected to the respective elements, which may lead to the interaction of the RF-signal [12] between the elements that may lead to fractional change in the operating frequency. Hence we follow the new process illustrated bellow.

In the proposed testing methodology [1], we connect all tabs to the elements, and short rest of the elements, keeping one of the element open for which tuning/matching has to be done. This process itself involves the interaction between the elements, and the frequency set during this condition will not alter in later stages.

Advantages of the preferred testing process are stability in the operating frequency [2], reduced time in testing process (avoids the iterative steps), increase in efficiency and may lead to the elimination of decoupling process, which is the step followed after the tuning/matching.

3. Image Processing

The image processing steps for the cancer detection are as follows:

1. Given the MRI colorectal image with cancer as input
2. Pre-processing steps for received image
3. Compute the Median filtering
4. Compute Threshold and watershed segmentation
5. Compute morphological operation.

A. Pre-Processing Methods:

Use a small neighborhood of a pixel in an input image to get a new brightness value in the output image. Such pre-processing operations are called filtration. Local pre-processing methods can be divided into smoothing, linearization, averaging, and filtering.

B. Median filtering:

This method is used to remove salt and pepper type of noises. Salt and Pepper noise Equation is given in equation (1). Each pixel in an image has the probability of p/2 (0<p<1) being contaminated by either a white dot (salt) or a black dot (pepper).

$$Y(i,j) = \begin{cases} 255, & \text{probability } (p/2) \\ 0, & \text{probability } (p/2) \\ X(i,j), & \text{probability } (1-p) \end{cases} \quad (1)$$

X: noise free image, Y: noisy image

C. Segmentation:

The goal of image segmentation is to cluster pixels into salient image regions [9], i.e., regions corresponding to individual surfaces, objects, or natural parts of objects. Segmentation could be used for object recognition occlusion boundary estimation within motion or stereo systems.

We considered watershed and threshold segmentation. Thresholding is the simplest Image Segmentation method; this method is based on threshold value to convert the gray level image into a binary image. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method [6], Otsu's method (maximum variance), and et al k-means clustering can also be used.

A watershed is a basin-like landform defined by highpoints and ridgelines that descend into lower elevations and stream valleys. Intuitively [9], a drop of water falling on a topographic relief flows towards the "nearest" minimum. The "nearest" minimum is that minimum which lies at the end of the path of steepest descent. In terms of topography, this occurs if the point lies in the catchment basin of that minimum. A grey-level image may be seen as a topographic relief [6], where the grey level of a pixel is interpreted as its altitude in the relief. A drop of water falling on a topographic relief flows along a path to finally reach a local minimum. Intuitively, the watershed of a relief corresponds to the limits of the adjacent catchment basins of the drops of water. In image processing, different watershed lines may be computed.

D. Morphological Operations:

Morphological image processing is a collection of nonlinear operations related to the shape or morphology of features in an image. Morphological operations rely only on the relative ordering of pixel values [4], not on their numerical values, and therefore are especially suited to the processing of binary images.

Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighborhood of pixels [8]. Some operations test whether the element "fits" within the neighborhood, while others test whether it "hits" or intersects the neighborhood [11]: A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image.

4. Experimental Results and Discussions

The output image from MRI after some changes made in the Receiver coils

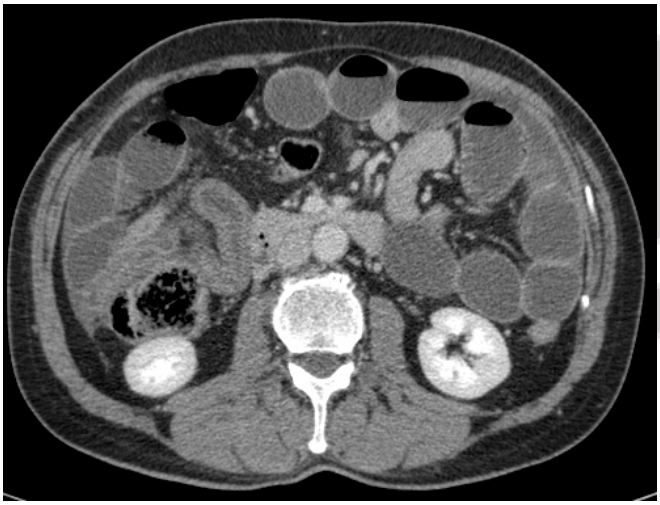

Figure 2, MRI colorectal image

The figure 2 shows the sectional view of the colorectal body part infected by the cancer; we got this output image after making some changes at the receiving section. Considering the figure 2, we move on to extract the cancer cells in it, and enhance the image quality for optimal diagnosing results for cancer treatment.

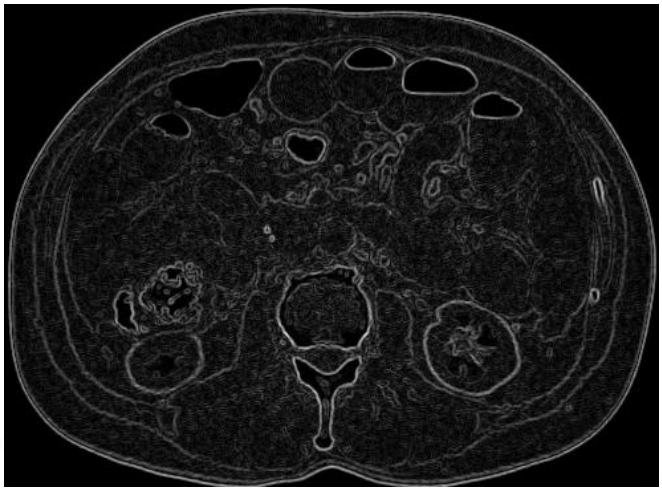

Figure 3, Showing Boundary object.

The figure 3, shows the boundary objects which is obtained after making preprocessing, magnetization and segmentation. This figure leads to the morphological operation, in which cancer cells are highlighted and the unaffected areas are removed which is shown in figure 4.

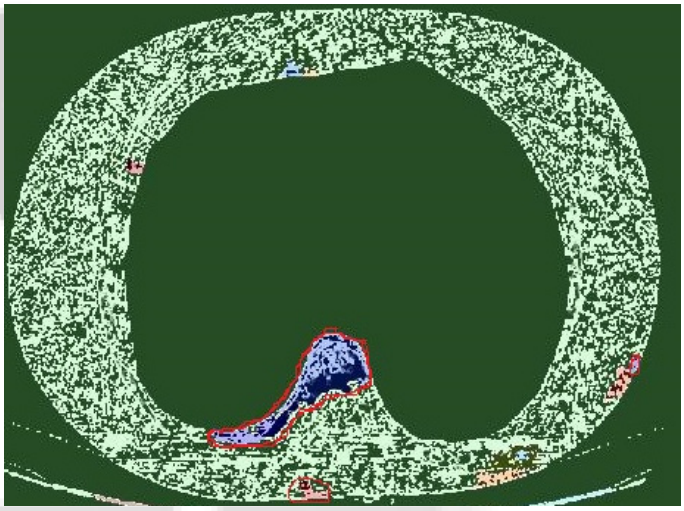

Figure 4: Image with highlighted cancer part

The enhancement of the image technique helps to show only the cancer affected body part clearly. After completion of extracting the cancer cells in an image, enhancement techniques can be used to alter contrast, brightness and rotational change on the image.

5. Conclusion

Dealing with the MRI-RF coils, fixing them to a constant operating frequency gives the right image, by which we get a better quality image. We mainly concentrated on cancer cell detection, which requires in clear observation and right reception of RF-Signals at the coil section. Later the image is extracted and enhanced to know the right position of cancer affected body parts.

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