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[Manivannan* *et al.*, 7(2): February, 2018]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

COLORECTAL CANCER DETECTION IN MRI IMAGES USING IMAGE PROCESSING TECHNIQUES

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DOI: 10.5281/zenodo.1173520

ABSTRACT

Cancer is a disease that begins in the cells of the body. Colorectal cancer is cancer that starts in the colon or the rectum. These cancers can also be referred to separately as colon cancer or rectal cancer, depending on where they start. When the body has extra cell growth it forms a growth or tumor. One of the key problems in the treatment of cancer is the early detection of the disease. Often, cancer is detected in its later stages, when it has compromised the function of one or more vital organ systems and is widespread throughout the body. Methods for the early detection of cancer are of utmost importance and are an active area of current research. Magnetic resonance imaging (MRI) established itself as the primary method for detection and staging in patients with colorectal cancer. In this paper, MRI images of colorectal cancer are used to detect the area and mean values of tumor area and distance from tumor area to other parts for staging cancer. This research paper describes algorithms for preprocessing, clustering and segmentation of MRI images. The implementation of this clustering, segmentation and preprocessing is done with Matlab 2015 (a). By using this proposed methodology the cancer is detected in its early beginning stage.

KEYWORDS: Colorectal Cancer, MRI images, Clustering, Adaptive K-means, Feature Extraction.

I. INTRODUCTION

In the modern era, cancer is the most spreading complex diseases. Identifying cancer without biopsy at an early stage is further imperative. And also, taking biopsy is not good for health also. In generally, cancer has been caused by hereditary instability and accumulation of multiple molecular alterations [1]. It also caused by cellular genes abnormal activation that controls cell growth or cell mitosis. Colorectal cancer is cancer from uncontrolled cell growth in the colon or rectum. This was the third most commonly diagnosed cancer in the world. Colorectal cancer is also known as colon cancer, bowel cancer or colorectal adenocarcinoma. The main negative aspect of cancer is its diagnosis and treated too late. Due to this problem, cancer has overtaken heart disease as the leading cause death for any age on. Therefore early detection of cancer is important.

Consequently, medical images can categorize into two types [7],

i. Structural Medical Images – these types of images are high-resolution images and it provides detailed anatomical information about the organ. For example, MRI, CT, and UltraSonoGraphy (USG) etc.
ii. Functional Medical Images – low spatial resolution images and it provides functional and metabolic information of an organ. For example, PET, SPECT etc.

Images are categorized by its modalities e.g., X-ray, CT, MRI, etc. Therefore, for proper medical diagnosis, medical images are processed and analyzed in an efficient way to provide more effective information. In general, image analysis refers to the extraction of meaningful information from digital images by means of digital image processing techniques. When the structure of the image is to be extracted, then the image is segmented based different characteristics. In the medical field, the digital image processing techniques are used to enhance the contrast or transform the intensity levels into color for easier interpretation of bio-medical images [7]. High-resolution MRI scanning plays an important role in the assessment of cancer. Basically, an image processing techniques contain the following steps, Preprocessing, Segmentation and Feature Extraction.

In preprocessing of this medical image contains a filtering method which preserves the edges from noises. In this paper median filter is used to remove the noise, it is a nonlinear filtering technique and it preserves the edges as much as possible while removing the noise. The contrasts along this edge are increased by sharpening the image [8]. A quick transition from black to white looks sharp where the gradual transition from black to grey

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

to white looks blurry. Therefore sharpening technique is used to enhance the images. Clustering techniques are also used on these bio-medical images so as to differentiate cancer tissues from the other textures. Clustering can be considered the most important unsupervised learning problem, so it deals with finding a structure in a collection of unlabeled data. The adaptive K-means clustering algorithm is used in this paper to find the cluster. This research work is implemented in Matlab 2015 (a).

The rest of the paper is structured as follows; section 1 provides the brief introduction to MRI medical images and Colorectal cancer. Section 2 discusses the various existing papers which are based on cancer detection and classification methods. It is followed by section 3 includes the proposed model of image preprocessing and segmentation. The next section 4 contains the discussions of the proposed method. Finally, section 5 brings the conclusion of the accuracy of cancer detection.

II. LITERATURE REVIEW

The following papers are motivated to propose the colorectal cancer segmentation methodology based on image processing techniques.

In 2017, Stefano Trebeschi et al., [6] developed a deep learning based network for the fully automatic localization and segmentation of locally advanced rectal tumors. The authors discussed that their results demonstrate accurate localization and segmentation of rectal cancer. This paper also studies the automatic segmentation procedures and how to overcome manual delineation.

In 2016, Namita Sengar et al., [5] proposed an automated system for grading of colorectal cancer using image processing method. The authors proposed a segmentation method by using intensity-based thresholding and organizational properties for classification. They said, in the existing methods of their literature review, it has some limitations about to find cancer in the beginning stage.

In 2016, Korsuk Sirinukunwattana et al., [3] presents a summary of Gland Segmentation in Colon Histology Images (GlaS). The authors discussed that their main objective is to find the cancer detection in its beginning stage. They evaluate the segmentation algorithms based on three criteria's such as accuracy of the detection, Volume based Accuracy and Boundary-based similarity.

III. METHODOLOGY

The colorectal cancer image segmentation using image processing techniques is starting by reading the image and then it will be preprocessed by using some techniques. And then the preprocessed image is segmented using clustering techniques. Finally, the clustered sub-image is selected and processed further. The proposed architecture design is shown in the following figure.

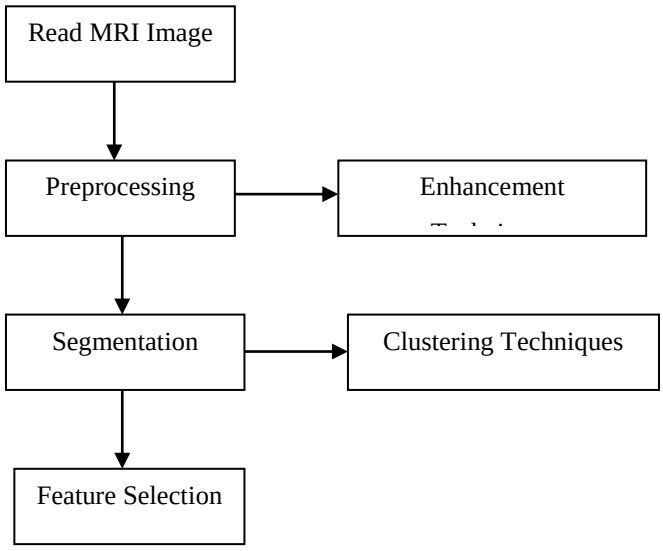

Figure. (3.1) Proposed Architecture

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

3.1 Image Preprocessing

The MRI medical image is preprocessed for enhancement. In this research work, it is done by first converting it into the gray image and applying two-dimensional median filters. A median filter is more effective than convolution when the goal is to simultaneously reduce noise and preserve edges. Median filter replaces all the image pixels at the same time with the median of image pixel values in predefined (3-by-3) neighborhood of the given pixel.

The following equation represents a generalized function for any neighborhood.

$$f'(m, n) = \text{med} \{ (-k \leq u, v \leq k) \{ f(m+u, n+v) \}$$

where we used k=1, the median is calculated over the 3-by-3 window, that is the size of the filter. The noise in resulting image f '(m, n) is reduced. Now the filtered image is sharpened by using unsharp masking. The unsharp masking technique comes from a publishing industry process in which an image is sharpened by subtracting a blurred version of the image from itself. The function sharpen in Matlab 2015 (a) returns an enhanced version of the grayscale input image A, where the image features, such as edges, have been sharpened. The following equation represents unsharp masking function.

$$g(m, n) = f(m, n) - f\,\text{smooth}(m, n)$$

where g(m, n) is enhanced the image, f smooth(m, n) is smoothed image of f(m, n).

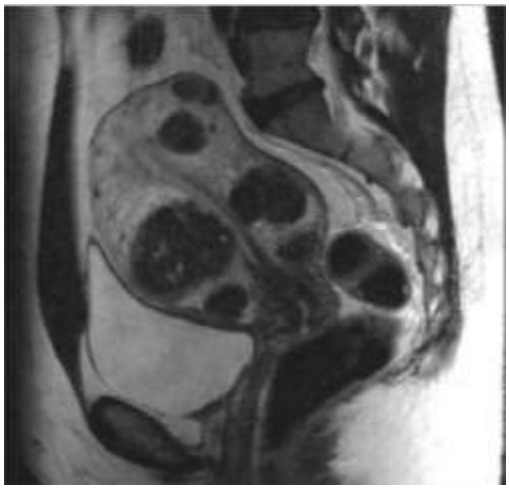

Figure (3.2). Original Image

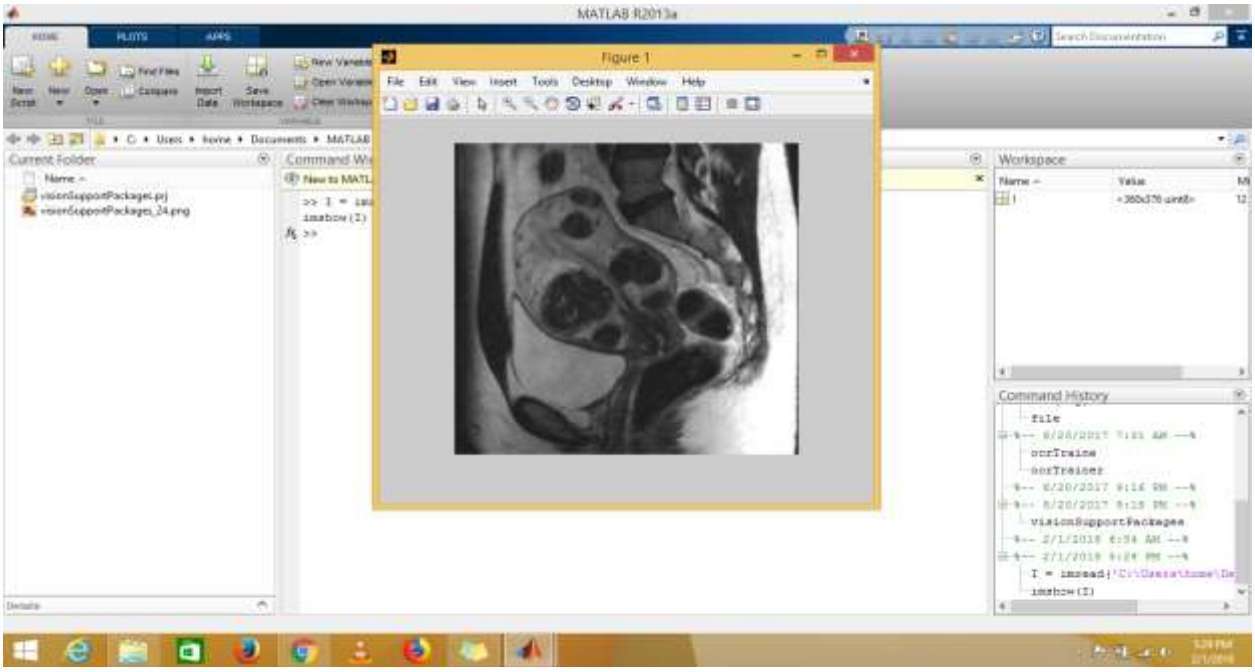

Figure (3.3). Enhanced Image

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3.2 Clustering algorithm

K-means based clustering technique is one of the popular techniques [2]. When the image is enhanced by using filtering method the adaptive K-Means clustering approach is used to find the clusters. The algorithm of this clustering approach starts with the random selection of initial seeds from the image, these seed properties also from the properties of the cluster. The function uses the Euclidian distance from the centroid to quantify how close two objects are to each other.

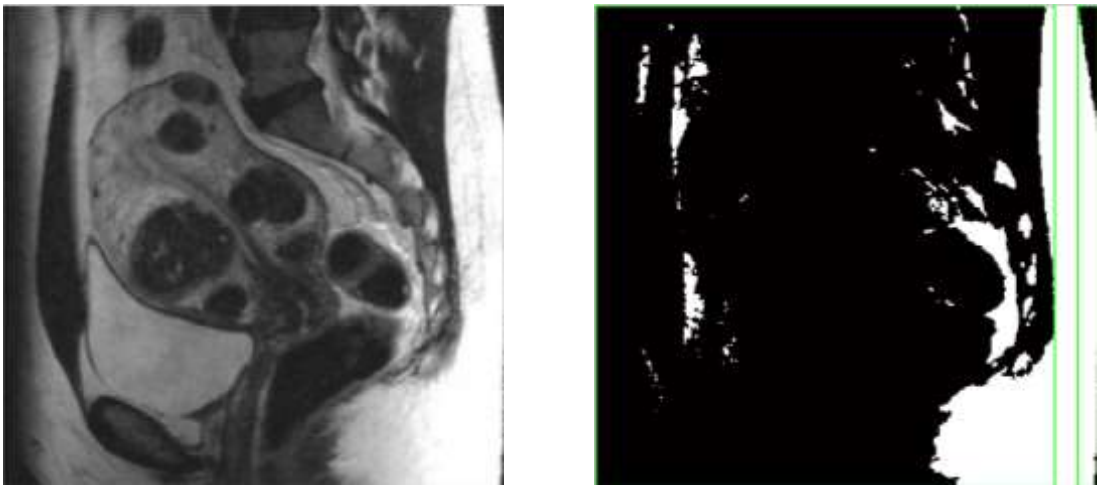

Figure (3.4). Objects in Clusters

This algorithm is a fully automatic way to cluster an input image using k-means principle, but here we do not need to specify the number of clusters or any initial seed value to start iteration, this algorithm automatically finds the number of cluster and cluster center iteratively. It is a very fast implementation of clustering an image without knowing the number of clusters.

3.3 Feature Selection

In this section, the clustered image that is close to the required data is selected and processed further. The objects are selected from the clustered image by adding coordinates using mouse pointer. The binary image containing objects are returned by the function between select and boundaries are drawn for the selected objects as shown in the below figure. And the properties such as area and mean values are calculated for the objects selected using region properties.

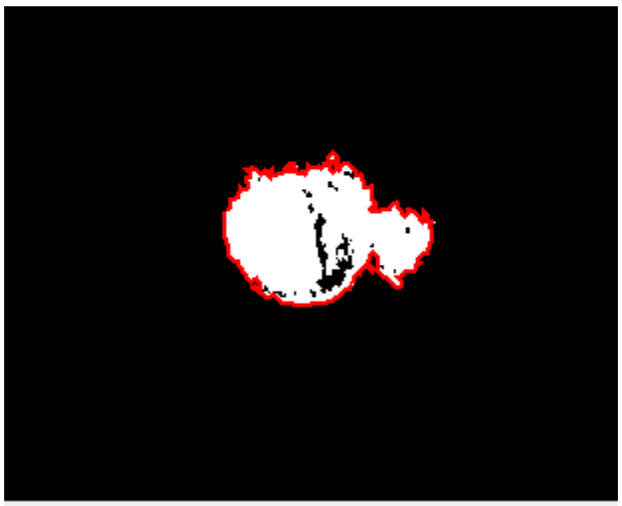

Figure (3.5). Selected Object

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Impact Factor: 5.164
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Area is calculated by the following equations,

Area = ((pr)1\2) *0.264. (3)

where pr is the number of pixels in the region. Using distance line function we draw a line by default on the figure and used to calculate the distance between cancer boundary and the other parts in the image. In T2 weighted axial rectal MRI, the connective tissue and fat around the rectum are referred as mesorectum and visceral fascia surrounding it is the mesorectal fascia.

IV. RESULT AND DISCUSSION

In general, an image processing system has a number of distortion or artifacts, so the quality measure is the significant one to be considered. There are several metrics and parameters that can be used to evaluate the quality of the image [4]. In this research work, the processed medical image quality is analyzed with PSNR and MSE.

Peak Signal-to-Noise Ratio

PSNR value characterizes the quality of the reconstructed image. When the PSNR value is low, it confirmed the image quality is enhanced.

$$\text{PSNR= 10 log } \frac{(2^{n}-1)}{MSE} = 10\log\frac{255^{2}}{MSE}$$

Mean Square Error

MSE is the differentiation between the original and reconstructed images average of the squares of the errors. The maximum value of MSE leads the efficiency of the proposed method.

$$\text{MSE} = \frac{1}{MN}\sum_{j=1}^{M}\sum_{K=1}^{N}\left(x_{j,k} - x'_{j,k}\right)^{2}$$

In this research paper 5 various cancer medical images are tested to find the results. The PSNR and MSE values of the tested images are discussed as follows.

Table (1). Enhancement Analysis

Images	PSNR	MSE
Image 1	14.1999	23.9137
Image 2	18.4530	29.2649
Image 3	14.0689	28.9438
Image 4	13.0673	27.6614
Image 5	14.2407	29.8490

After clustering the sub-image is selected for post-processing. In this research paper, it proposes a framework where the area and mean of the tumor are calculated. These values are useful for future analysis. The following table shows the values for the input images.

Table (2). Tumor Details

Images	Area	Mean Value
Image 1	33.185	55.591
Image 2	33.076	80.171
Image 3	29.649	40.964
Image 4	16.205	25.314
Image 5	31.188	51.801

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The distance between the cancer growth and mesorectal fascia is traced for staging cancer. TNM is the model followed for staging rectal cancer. T is tumor, N is node and M is distance metastasis. In this research paper, T-staging is done and it is only for adenocarcinoma and not for other tumors. T-staging is based on the distance between tumor and other parts of the body. The distance to the mesorectal fascia is the single most important local prognostic factor therefore; a distance line tool is used to find the distance between the tumor and the mesorectal fascia as it surrounding the rectum. The distance tool is draggable, resizable line. Finding T3 stage is a crucial one as cancer may spread to other organs of the body. When the tumor enters the mesorectal fat the shortest distance between the tumor and the mesorectal fascia is calculated in the proposed framework. When the tumor reaches the mesorectal fascia the chances of tumor spreading to other organs are more.

V. CONCLUSION

Early detection of cancer stage is very important in the medical field. In this research paper, we proposed a framework to enhance the input MRI image by image processing techniques and segmentation is done by using adaptive k-means clustering algorithm for the analysis of colorectal cancer. High-resolution MRI image plays an important role in the assessment of cancer. The area of the calculation, mean of the tumor and the minimum distance from tumor to other parts is calculated in this paper. This helps the radiologist in staging cancer in its initial stage.

VI. REFERENCES

[1] Gayathri Devi. K., Radhakrishnan, R., Kumar Rajamani.: Computer Aided Diagnosis Scheme for Polyp Detection in CT Colonography Using K-Means Clustering and SVM. World Journal of Medical Sciences 9 (4): 2013 ISSN 1817-3055, pp. 273-281.
[2] Jinyong Cheng, Xiaoyun Sun.: Medical Image Segmentation with Improved Gradient Vector Flow Research Journal of Applied Sciences. 2012 ISSN: 2040-7467, pp. 3951-3957.
[3] Korsuk Sirinukunwattana et al., “Locality Sensitive Deep Learning for Detection and Classification of Nuclei in Routine Colon Cancer Histology Images”, IEEE Transactions on Medical Imaging (Volume: 35, Issue: 5, May 2016), pp. 1196 – 1206.
[4] Michael R. Torkzad, Lars Pahlman and Bengt Glimelius," Magnetic resonance imaging (MRI) in rectal cancer: a comprehensive review", European Society of Radiology, Insights Imaging (2010) 1, pp. 245–267.
[5] Namita Sengar et al., “Grading of colorectal cancer using histology images”, Telecommunications and Signal Processing (TSP), 2016 39th International Conference, 01 December 2016.
[6] Stefano Trebeschi et al., “Deep Learning for Fully-Automated Localization and Segmentation of Rectal Cancer on Multiparametric MR“, Sci Rep. 2017, doi: 10.1038/s41598-017-05728-9, Published online 2017 Jul 13.
[7] P.Subhasri and Dr. A. Padmapriya, “ Enhancing the Security Of Dicom Content Using Modified Vigenere Cipher”, International Journal of Applied Engineering Research, ISSN 0973-4562 Vol. 10 No.55, May 2015, pp. 1951-1956.
[8] Usama Ghieda, Omar Hassanen, and Mohamed A. EltomeyA, "MRI of rectal carcinoma: Preoperative staging and planning of sphincter-sparing surgery", The Egyptian Journal of Radiology and Nuclear Medicine (2014) 45, pp. 1–5.