SEGMENTATION OF POLYPS FROM COLONOSCOPY IMAGES USING MATLAB'S IMAGE PROCESSING AND COMPUTER VISION TOOLBOX

Aim:

To segment and validate the segmentation of polyps from colonoscopy images using Image Processing and Computer Vision toolbox in MATLAB.

Objectives:

- To download and launch Image Processing and Computer Vision Toolbox in MATLAB
- To load RGB colonoscopy images in the workspace
- To extract the red, green and blue channels from the images
- To segment polyps using active contour model in the interactive Image Segmenter GUI
- Identify appropriate parameters for segmentation
- Calculate the Dice coefficient of segmented results

Apparatus required:

- Laptop
- MATLAB

Theory:

Colorectal cancer has the second and the third highest incidence rates in the females and males, respectively. Early diagnosis has a huge impact on the survival from colorectal cancer. Colorectal polyps are potential prognostic indicators of the colorectal cancer, and colonoscopy is the gold standard for the biopsy and the removal of colorectal polyps. Segmentation of these polyps is essential for the analysis and accurate diagnosis of cancer. Therefore, it becomes increasingly important to develop reliable methods for the detection and segmentation of polyps.

Many image processing methods have been applied for polyp segmentation. Image filters and edge detector algorithms has been used for automatic segmentation of these regions. Clustering algorithms have also been employed to localize and segment polyp contours. Active contours are the technique of obtaining deformable models or structures in an image with constraints and forces for segmentation. Contour models define the borders of the structure to generate a parametric curve or contour. However, the active contour-based segmentation is sensitive to the contour initialization. The curvature of the models is determined by the external and internal forces. External energy is described as the sum of forces that is specifically used to control the location of the contour onto the image, and internal energy is used to govern the deformable changes.

To validate the effectiveness of the algorithm in polyp segmentation, Dice coefficient is employed to compare the segmented results with ground truth masks.

Method:

Download and install 'Image Processing and Computer Vision' toolbox and launch MATLAB. Load the RGB colonoscopy image and extract the red, green and blue channels. Launch 'Image Segmenter' GUI and load the original image from workspace. Initialize a circular contour at the approximate center of the polyp. The radius of the polyp is set to approximately half the size of polyp. Fix the number of iterations and run the active contour model. Generate the binary mask of the segmented region. Export the mask to the MATLAB workspace. Validate the segmentation result using the Dice coefficient overlap measure. The Dice coefficient is given as:

$$DSC = \frac{2 \times |X| \cap |Y|}{|X| \cup |Y|}$$

Where X and Y are the segmented binary image and ground truth masks respectively. Repeat the same procedure for images extracted from red, green and blue channels. Compare the active contour model parameters and Dice coefficient.

Results:

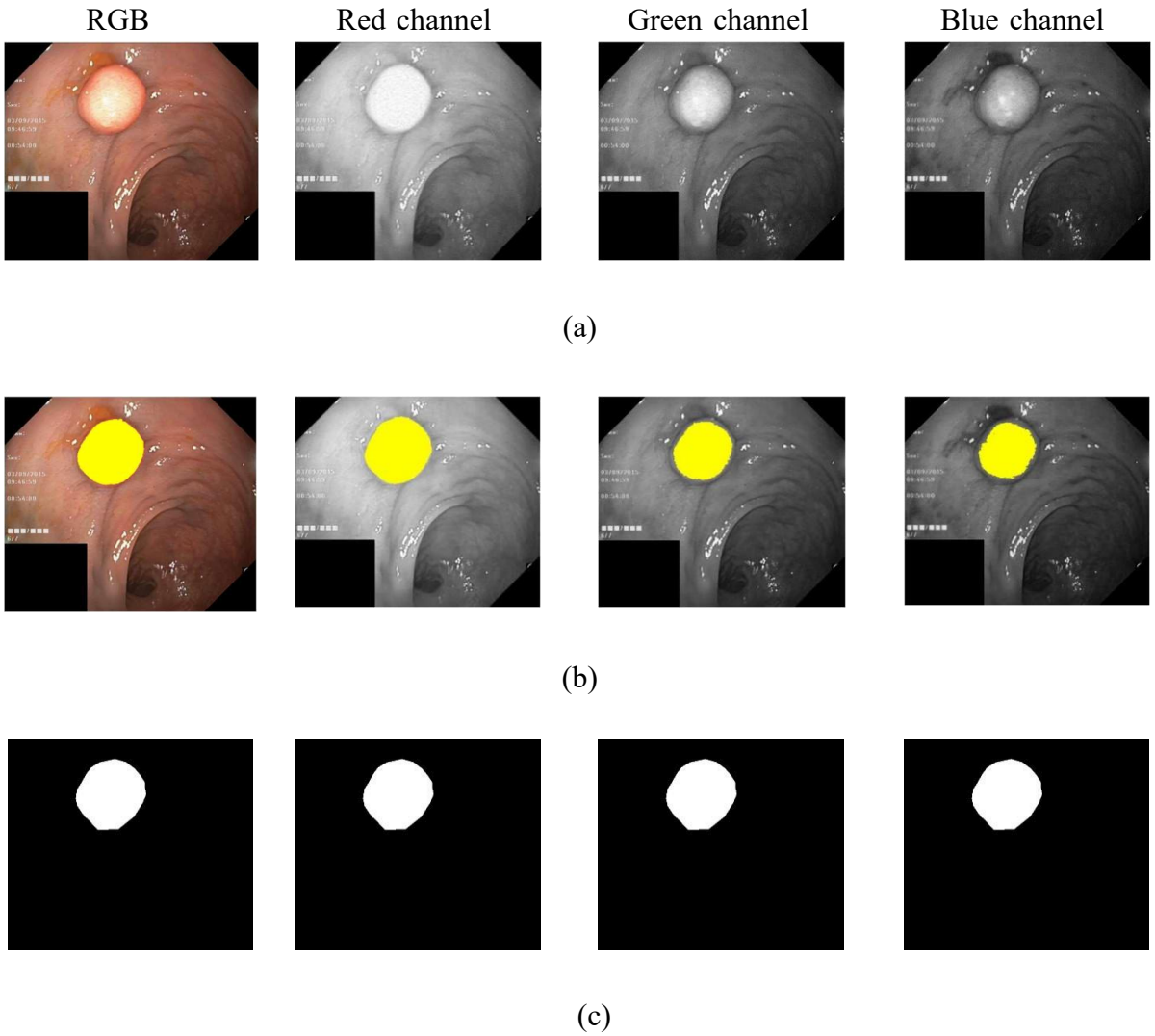

Figure 1. Representative (a) RGB, red, green and blue channel images, (b) overlay of segmented images and (c) ground truth mask

Representative RGB, grayscale red, green and blue channel images, overlay of segmented images, and ground truth masks are shown in Fig. 1 (a), (b) and (c) respectively. The segmented and ground truth images are compared using Dice coefficient and are tabulated in Table 1. The number of iterations varies from 50 to 200 in steps of 50 iterations. The corresponding Dice coefficients obtained are recorded in Table 1.

Table 1. Dice coefficient of segmentation results

No: of iterations	Images	RGB	Red channel	Green channel	Blue channel
50	Image 1	0.9255	0.9537	0.8183	0.7846
	Image 2	0.7929	0.8984	0.8953	0.7814
	Image 3	0.8513	0.7934	0.7933	0.8258
	Image 4	0.9063	0.7574	0.7412	0.6805
100	Image 1	0.9265	0.9239	0.8184	0.7801
	Image 2	0.8277	0.8974	0.8882	0.8047
	Image 3	0.8264	0.8188	0.8086	0.7692
	Image 4	0.6723	0.5694	0.7192	0.6727
150	Image 1	0.9267	0.8486	0.8185	0.7799
	Image 2	0.8020	0.8818	0.8555	0.8029
	Image 3	0.7283	0.7774	0.8136	0.7884
	Image 4	0.5260	0.5124	0.6353	0.6734
200	Image 1	0.9264	0.7178	0.8185	0.7803
	Image 2	0.8060	0.8790	0.8210	0.7949
	Image 3	0.7313	0.6907	0.7814	0.7848
	Image 4	0.4143	0.4468	0.5696	0.6761

- Comprehensive study on the segmentation of RGB images
- Identification of appropriate parameters for active contour-based segmentation using the Image Processing and Computer Vision Toolbox in MATLAB

Conclusion:

By setting appropriate parameters in active contour model of MATLAB's Image Processing and Computer Vision Toolbox, polyps can be accurately segmented from colonoscopy images.