Center Line Detection for Virtual Colonoscopy

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Abstract: **The study showcases an approach of employing virtual colonoscopy to detect 'polyps' and cancerous outgrowths in the large intestines of patients along with bringing forth a procedure to materialize the process. Virtual colonoscopy aims to provide an easier and less painful option fordiagnosing cancerous and pre-cancerous outgrowths in the colon. Modified Ma and Sonka's algorithm. These algorithms are used to find the location and shape of colons.**

Keywords: Ct Scan Images, Segmentation, 3d Component Labelling, Skeletonization, Ma And Sonka's Algorithm.

I. INTRODUCTION

Virtual colonoscopy is a procedure used to look for signs of precancerous growths, called polyps, cancer and other diseases of the large intestine. Images of the large intestine are taken using computerized tomography (CT). Computer tomography (CT) is a procedure that takes hundreds of cross-sectional rays in a few seconds. Like putting together a loaf of bread from its many slices, a computer puts cross-sectional x-ray pictures together to form whole images of internal organs. In Virtual colonoscopy an animated, three-dimensional view of the inside of the large intestine is reconstructed using images of the large intestine and the inner surface of the model is rendered for the detection of the location, size and shape of the Polyps.

This paper assumes the availability of CT scan images and divides the images into following steps

- Extraction of Colon
- Finding the centre line of Colon
- Surface rendering to reconstruct the inner surface of Colon

II. THEORY

II- A Plan and Procedure to design a Virtual Colonoscopy

In this section, we want to present an overview of the proposed virtual colonoscopy system on the PC platform. To extract the inner surface of the patient colon, there are several preprocessing steps including patient preparation, air inflation into the colon, and surface extraction. Before we present to you the proposed technique let us give to you the algorithm which is as follows;

A. Use of Computerized Tomography procedures to take the 3D images of colon
B. Extraction of colon that includes segmentation and 3D region growing.
C. Skeletonization to find the center line detection by using Ma and Sonja's Algorithm
D. Surface Reconstruction and surface rendering based fly through a virtual camera.

The procedure for center line extraction of the colon produces a center line along with many branches due to that fact the inner surface of the colon is irregular in nature leading to cross sections of various types

II- B CT Imaging

Using a conventional Computed Tomography imaging system we fist obtain the images of the entire abdomen of the subject which are obtained in form of a number of 2D images. When such images are combined using specific computer programs we get a highly detailed multi-dimensional view of the colon.

II- C Segmentation

Image segmentation aims to group the image elements, or vowels, of the same tissue in a 3D space. The unique feature in the image segmentation is the use of the similarity of same tissue types. Various methods for the segmentation of colon from the 3D CT data are proposed [1-5]. We used multi-thresholding; 3D region growing and 3D connected component labelling algorithms for the purpose of segmentation.

II-C-1 Multi-Thresholding

We set two intensity levels as lower and upper thresholds and any vowel having intensity in between the thresholds belongs to the colon otherwise it is a background vowel. This in turn converts the volume image into a binary image leading to saving of a huge amount of memory.
The value of the upper threshold and lower threshold is decided by the user by observing the two dimensional images or these value can be decided automatically by the seed point entered by the user. In the developed virtual colonoscopy tool there is a provision to enter the upper and lower threshold value by using a dialog box. The drawback of this method is we have to enter the lower and upper threshold.Another drawback is that the technique is very sensitive to noise and intensity in homogeneities.

II-C-2 3D Region Growing Algorithm

3D Region growing is a technique to extract a connected region from a 3D volume based on some predefined connecting criterion. The 3D region growing algorithm used here is based on the queue and a three dimensional flag. The algorithm is as follows:

I. Clear all the points in 3D flag volume.

II. Set the flag value corresponding to seed point and push the seed point on the queue.

III. While queue is not empty

III A) Take out the a point P(x, y, z) from the queue

III B) check the 26 neighborhood points of P(x, y, z) if Flag is equal to zero then flag is set to one and that point is added to the queue.

IV. Check every point in 3D flag volume if it is equal to one set that point .Otherwise reset that point to zero.

The primary disadvantage of this algorithm is that it requires seed points which generally means manual interaction. Region growing can also be sensitive to noise and partial volume effect causing the extracted region to have holes or disconnections.

II- D Skeletonization

We used Modified Ma and Sonka's algorithm proposed by Tao Wang and Anup Basu for the thinning of the colon. But the result obtained after this in not a thin single line. It include many branches because the cross section area of the colon is different at different location and also the shape is not uniform .To trim these redundant branches we used another algorithm named two pass tracking method.

II-D-1Two pass tracking method

To trim the redundant branches obtained after applying the modified Ma and Sonka's algorithms Two pass tracking method is used .Before trimming the branches, the two-end points (starting and ending fly points) of the flight path are specified. To automate the process starting point is automatically calculated from the lower portion of the colon and end point is obtained after the first pass.

II- ESurface reconstruction using Marching Cube Algorithm

Marching Cubes [14] is a computer graphics algorithm for extracting a polygonal mesh of an isosurface from a three dimensional scalar field (sometimes called voxels) There are two primary steps in Marching Cube Algorithm to the surface construction problem. First one is to locate the surface corresponding to a user-specified value and create triangles.Then, to ensure a quality image of the surface, calculate the normal to the surface at each vertex of each triangle.

II- F Implementation of the Fly Path and Navigational Environment of virtual camera

We developed a Graphical User Interface in which 2D slice views of the transverse, sagittal and coronal images are available. The 3D volumetric rendered view is also available.

Navigation through the entire colon lumen can be achieved by either surface- or volume-based rendering computer graphics techniques. The surface-based navigation is efficient (i.e., in real time), but lacks rendering quality in terms of the surface smoothness, and most importantly, it lacks information beyond the surface. We used the perspective projection for the visualization. In the Perspective projection three things are required for the virtual camera. First one is the location of the virtual camera,second one is the location of target point and third one is the direction of camera.

III. RESULTS

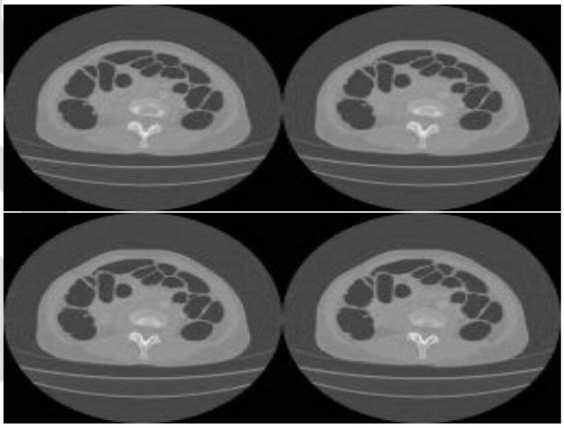

Fig. 1: Original CT Images

Fig. 2: Image after thresholding

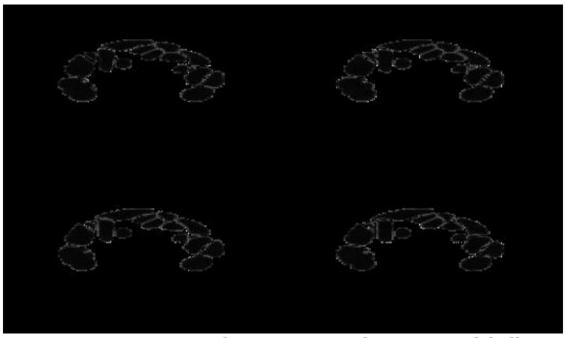

Fig. 3: Image by 3D connected component labelling

Fig. 4: Image by 3D Region Growing

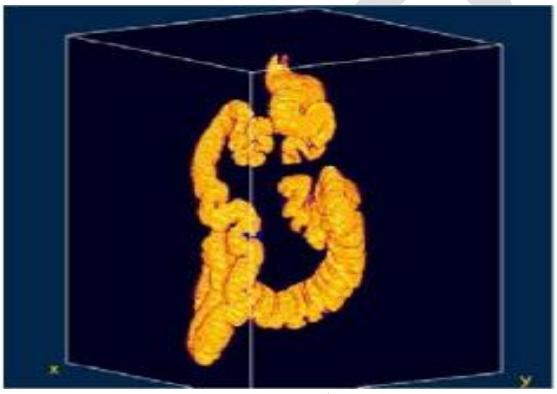

Fig. 5: 3D view of hollow colon

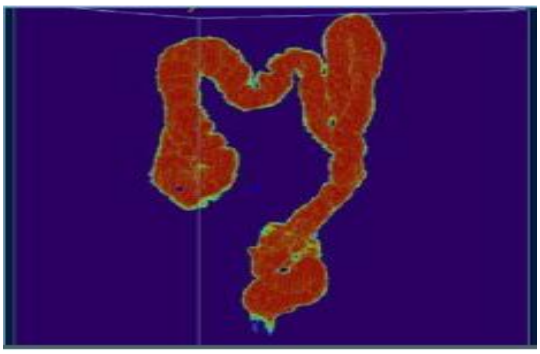

Fig. 6: 3D view of colon by Region Growing

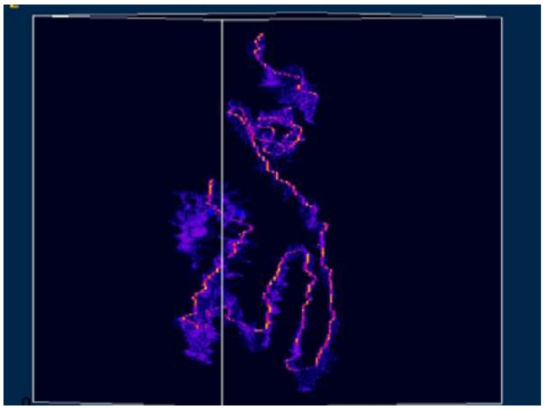

Fig. 7: 3D view of centre line after modified Ma and Sonka's Algorithm

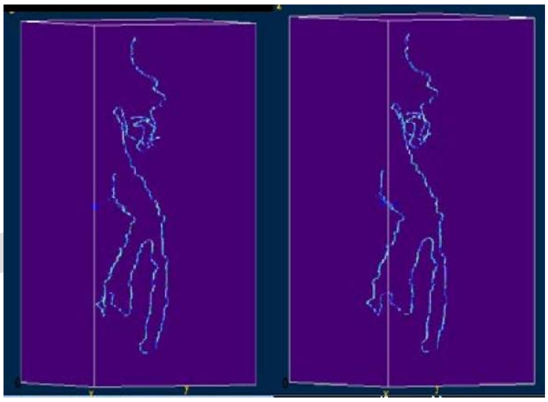

Fig. 8: Different 3D view of centre line after modified Ma and Sonka's and two pass tracking algorithm

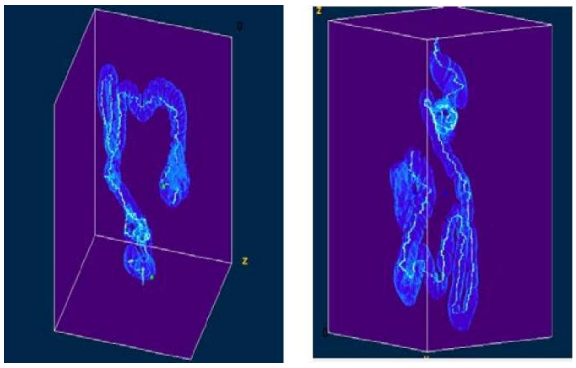

Fig. 9: 3D views of centre line and hollow colon

IV. CONCLUSION

Thus an effort is put to bring forth a simple working model for virtual colonoscopy we have seen that segmentation and center line detection are of utmost importance as the generated view of the colon very much depends on these two. Extensive research is proposed for center line detection as that gives flexibility to camera fly(movement).

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