A Survey of Colorectal Cancer Detection Using Various Segmentation Techniques in Image Processing

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Abstract— Colorectal cancer is cancer that starts in the colon or the rectum inside the large intestine. Detecting and screening of colorectal cancers are done by a Computed Tomography (CT) colonography. Digital images of colon polyps are analyzed to detect the colon cancer at an early stage. The goal of segmentation approach is to segment the cancer region accurately. In this paper, various segmentation techniques of colorectal cancer detection are discussed. Several methods and algorithms are used to capture the thin boundary of the cancer images. The segmented candidates are typically characterized by features describing like the polyp shape and its internal intensity distribution. The aim of each paper is to attain greater accuracy and to produce good segmentation results of colonic polyps.

Keywords: - Colorectal cancer, CT Colonography, Image Segmentation, Virtual Colonoscopy, Deformable surface

I. INTRODUCTION

Digital image processing has huge applications in different technology and study. Fields that use digital image processing include: biological researches, finger print analysis, medical fields, publishing fields and photography.
The fundamental classes of Digital image processing are grouped depending on their operations:

(1) Image enhancement: image enhancement deals with contrast enhancement, spatial filtering, frequency domain filtering, edge enhancement and noise reduction.
(2) Image restoration: in this class, the image is corrected using different correction methods like inverse filtering and feature extraction in order to restore an image to its original form.
(3) Image analysis: image analysis deals with the statistical details of an image. Here it is possible to examine the information of an image in detail. This information helps in image restoration and enhancement. One of the representations of the information is the histogram representation to show the brightness and darkness in order to arrange and stretch the images to have an enhanced image relative to the original image. During image analysis the main tasks include feature extraction, image segmentation and object classification.
(4) Image segmentation: image segmentation deals with the segmentation of the image to simplify or change the representation of an image into something that is meaningful and easier to analyze.
(5) Image compression: image compression deals with the compression of the size of the image so that it can easily be stored electronically. The compressed images are then decompressed to their original forms. Here the image compression and decompression can either lose their size by maintaining high quality or preserves the original data size without losing size.
(6) Image synthesis: this class of digital image processing is well known nowadays in the game industry and film. Nowadays the game industry and film is very advanced in 3-dimensional and 4-dimensional productions. In both cases the images and videos scenes are constructed using certain techniques. The image synthesis has two forms tomography and visualization.

A. *Image Segmentation Process*

Image segmentation is the process of partitioning a digital image into several segments such as set of pixels. To locate objects and boundaries (lines, curves, etc.) in images, image segmentation is typically used. More exactly, the process of image segmentation is assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. A set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection) would be resulted. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).[1] When applied to a stack of images, typical in medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like marching cubes.

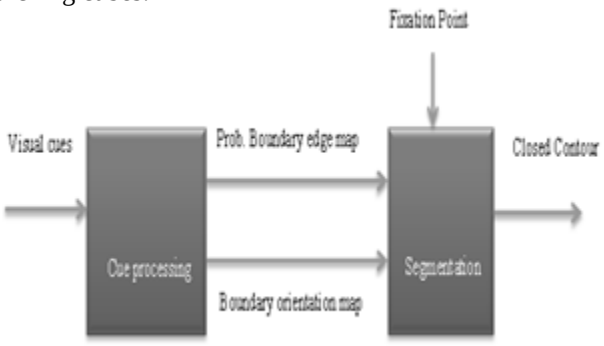

Fig. 1: shows the model of segmentation process

B. *Edge detection*

Edge detection is a well-developed field on its own within image processing. Region boundaries and edges are closely related, since there is often a sharp adjustment in intensity at the region boundaries. Edge detection techniques have therefore been used as the base of another segmentation technique. The edges identified by edge detection are often disconnected. To segment an object from an image however, one needs closed region boundaries. The desired edges are the boundaries between such objects. Segmentation methods can also be applied to edges obtained from edge detectors. Lindeberg and Li [2] developed an integrated method that

segments edges into straight and curved edge segments for parts-based object recognition, based on a minimum description length (MDL) criterion that was optimized by a split-and-merge-like method with candidate breakpoints obtained from complementary junction cues to obtain more likely points at which to consider partitions into different segments.

C. Colorectal Cancer

Colorectal cancer is cancer that starts in the colon or the rectum inside the large intestine. These cancers can also be referred to separately as colon cancer or rectal cancer, depending on where they start. It is the second leading cause of death among cancers and is the third most common form of cancer in the United States. Given the fact that colorectal cancer is a largely preventable disease through routine detection and removal of adenomatous polyps, colon cancer prevention has now moved to the forefront. Most colorectal cancers begin as polyps. As polyps enlarge, they are more likely to develop into a cancer as shown in figure 2, which has the ability to disseminate through the body. The most important colorectal polyp is the adenoma, a small benign tumor growing to about 2 cm in size. Colonic adenomas are common and in the majority of patients there is no side effect on health. They are more common with increasing age. Appropriate evidence are shown that colonic adenomas are the early stage of colorectal cancer, although only a very small percentage of adenomas turn into malignant tumor and it may take nearly five to 15 years to change. Polyp size is considered to be one of the most important factors in distinguishing benign polyps from cancerous ones. After detection and classification, accurate polyp segmentation could provide an easy way to measure polyp size, enhancing and improving the detection of significant lesion. Computer tomographic colonography is a minimally invasive technique and rapidly evolving diagnostic tool for the location, detection and identification of benign polyps on the colon wall on the early stage before their malignant transformation.

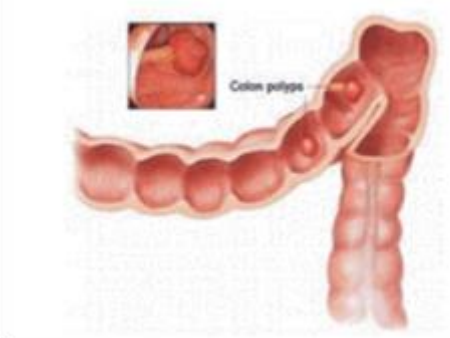

Fig. 2: shows the polyps situated on the colon wall

Several methods were proposed for colonic polyp segmentation and detection.

D. Applications of Image Segmentation

Applications in the field of image segmentation are

1. In the area of medical imaging, image segmentation plays a vital role. Segmentation is used for locate tumors and other pathologies. It is used to measure tissue volumes, diagnosis and in the study of anatomical structure.
2. The expanding area of application for digital image restoration is that in the field of object detection. As techniques are developed to improve Pedestrian detection, Face detection, Brake light detection, Locate objects in satellite images (roads, forests, crops, etc.).
3. Another important application of segmentation technique is used to recognize different tasks such as Face recognition, Fingerprint recognition, and Iris recognition.
4. Digital image segmentation is also used in content-based image retrieval, machine vision, traffic control system and video surveillance.

II. Related Study

[3] In this paper, a framework is presented for colonic polyp detection and segmentation. Four different geometric features used for colonic polyp detection, which include shape index, curvedness, sphericity ratio and the absolute value of inner product of maximum principal curvature and gradient vector flow. Then the bias-corrected fuzzy c-mean algorithm and gradient vector flow based deformable model used for colonic polyp segmentation. Finally, the overlap between the Manual segmentation and the algorithm segmentation is measured to test the accuracy of our frame work.

[4] Virtual colonoscopy is a prominent screening technique for colon cancer. A part of virtual colonoscopy, image pre-processing, is significant for colonic polyp detection/diagnosis, feature extraction and classification. This chapter aims at an accurate and fast colon segmentation algorithm and a general variational-approach based framework for image preprocessing techniques, which include 3D colon isosurface generation and 3D centerline extraction for navigation.

[5] An adaptive level set method for segmenting colon filled with air and opacified fluid in CT colonography. Simple thresholding method is used to remove most of the opacified liquid. Then, closed contours with manual seeds initialization are propagated toward the desired region boundaries through the iterative evolution of an adaptive 3D implicit function. Information about the regions is considered by approximate calculation of the parameters of probability density function (PDF) in step-by-step iteration. The accuracy of the proposed method is evaluated by computing the overlap between the manual segmented colon and the results segmented by the algorithm.

[6] In this paper, a novel method is proposed in order to reduce the computational time taken by the CAD system for the detection of growth in abdominal CT images for the identification of colorectal cancer. In the proposed CAD system, segmentation of the colon is done by Otsu's method of thresholding and clustered by K-Means clustering for the extraction of the features such as intensity texture and volume in order to classify the polyps. The segmented candidates are typically characterized by features describing, for instance, the polyp shape and its internal intensity distribution. Such features will serve as input for the classification system. Classification is performed by SVM (Support Vector Machine) and ANN (Artificial Neural Network).

[7] An improved 3D method for colonic polyp segmentation was developed based on 2D method. The

method is based on combination of 3D knowledge-guided intensity adjustment, fuzzy clustering, and dynamic deformable surfaces. A deformable surface is used to locate the polyp boundaries after intensity adjustment and fuzzy clustering. To preserve the resolution and topology, the surface is maintained dynamically. The deformable surface is managed on a sub-volume of the data set and driven by image forces, balloon forces and internal spline forces. The improved method produces much smoother polyp boundaries, and 3D features can be derived from the segmentation, such as 3D aspect ratio, curvatures, and polyp wall thickness etc., when compared to 2D method. The computer segmentations were validated with manual segmentations.

[8] The aim of semantic segmentation in microscopic images is to extract the cellular, nuclear or tissue components. This problem is challenging due to the large variations of features of these components (size, shape, orientation or texture). An overview of the proposed segmentation techniques for microscopic images is presented in this paper. It is an analysis of the most used image processing methods in this particular domain. The existing techniques are grouped by their application in one of the following pathological field: cytology vs. histology. Beside a rough description of each method, a useful statistic and discussion about the frequency of the most used image processing methods in the problem of microscopic image segmentation is introduced. This analysis is helpful for a better use of existing method and for improving their performance as well as for designing new ones.

III. Conclusion

Edge detection is a fundamental of low-level image processing and good edges are necessary for higher level processing. It plays vital role in the field of Computer Vision. Image edge detection refers to the extraction of the edges in an image. Filtering is one of the most common applications of image processing. By filtering we mean the processing of the image in order to remove or reduce a particular unwanted component for example noise, or to enhance or extract a particular set of features, such as edges. This study has been devoted to various existing edge detection techniques like edge detection using an adaptive level set method, the bias-corrected fuzzy c-mean algorithm and gradient vector flow based deformable model used for colonic polyp segmentation.

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