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Ulcer Segmentation from Endoscopic Images using Grow Cut method

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ABSTRACT

Ulcers are an outcome of the reaction and consequences of the digestive action of pepsin enzyme and the caustic part of the stomach acid. Ulcers are like a lesion in the mucous layer of the digestive tract. In the modern ascensions of the electronic field, segmentation of ulcers using endoscopic images has turned out to be an emergent area in the medical image processing discipline. Ulcer detection helps the user to determine the precise size of the ulcers. We have suggested a synergistic and an effective algorithm for the detection of ulcers based on noise filtering technique, and threshold segmentation and grow-cut segmentation. As the endoscopic ulcer images are freed from the unwanted noises by the aid of noise filtering techniques, eventually the thresholding segmentation is implemented to convert these filtered images to gray scale images. After these conversion the grow-cut segmentation is applied to get the exact ulcer affected area. The outcomes of the segmentation of ulcer images acquired by endoscopy are presented.

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INTRODUCTION

The segmentation of 3D images taking place in stages, it occurs before executing object recognition and plays a vital role in the recent ascensions in medical imaging[1]. Segmenting 3D images, aids us in the automatized detection of ulcers alongwith assisting in analyzing the qualitative and quantitative features of the images like calculating the size and refined volume of the detected ulcer.

Accurate measurements of ulcer detection is an arduous task as ulcers differs in appearances, sizes and shapes. Ulcers affects the tissues in vicinity which produces an abnormality in the structure for the robust tissues as well. Our propounded approach signifies the development of an efficient way of 3D segmentation of ulcers by the application of noise filtering techniques as well as threshold segmentation in addition with the grow-cut method.

In this propounded work, user can also guide and direct the algorithm if at all there is a necessity, but mostly no extra effort by the user is required. The segmentation is faithfully computed. The process starts with the acquisition of the endoscopic ulcer images and noise filtering technique i.e., the median filtering technique is applied to filter the image from the presence of unwanted noises. Eventually the Otsu's method for thresholding segmentation is

applied to procure the gray scale images. Finally the grow-cut segmentation is applied to get the exact ulcer affected area.

ULCERS:

Ulcers are engendered due to the response and effects of the digestive action of pepsin enzyme and the caustic part of the stomach acid. Ulcers are like a lesion which affects the mucous layer of the digestive tract. It occurs in the usually acidic medium based region- gastrointestinal tract. The frontal part of the intestine is four times as prone to ulcers when compared to the stomach itself. Ulcers are caused due to prolonged usage of aspirin and non-steroidal drugs, those which are anti-inflammatory in nature (generally known by the name "NSAID's"). A malignant tumor is the cause for about 4% of the ulcers. Due to this, multiple observations are to be made to rule out chances of cancer. The common symptoms for ulcer include abdominal pain, nausea, vomiting often, loss of weight and often appetite loss, hematemesis (cases where people vomit blood). Often, the location of occurrence of the ulcer differs with respect to age of the patient. Ulcers heal quickly and also tend to occur again resulting in excessive and continuous pain rather than lessening of pain. Cases where stomach pains last for more than thirty minutes to three hours often seem likely to

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have ulcer in their stomach. The following types of ulcer can be detected from the endoscopic ulcer images. They are as undergoes:-

A. *Types of Ulcers:*

There are two common types of ulcers, firstly, Gastric Ulcers and secondly, Duodenal Ulcers.

1) Gastric Ulcers:

These type of ulcers *mainly develops in the linings of the stomach. Mainly, these type of ulcers* are caused either, as a result of the infection *caused due to the bacteria known as, Helicobacter pylori (H. pylori)* bacteria or by the prolonged use of non-steroidal *drugs, those which are anti-inflammatory in nature (generally known by the name "NSAID's")*. Pain occurs while the food is still in the stomach. It may also happen immediately after eating.

2) Duodenal Ulcers:

These type of ulcers forms in the upper small intestine. These are also caused by the same factors as in the Gastric ulcers. In case of duodenal ulcers, pain occurs in the stomach while the stomach is empty, and the condition improves after eating.

Endoscopy:

The test that authenticates the existence of ulcer is known as endoscopy. Since 1960's, it has given us an extensive view for various gastrointestinal diseases. In this particular procedure, a thin flexible tube comprising of a light source, suction equipment, and a lens system, is passed down through the esophagus and the stomach into a specific region of the duodenum by a medical practitioner, which is under the direct vigilance and forwards the video clipping of the diseased tissue for exposition without a large laceration, the analysis and the storage. Live image formations are provided by the endoscopy of the upper GI tract and is being constantly used to distinguish the anomalies and holes present in the secure lining of the stomach or duodenum. The most familiar pathology found during the endoscopy are the diseased spots, anomalously associating mucosal folds, uplifted amorphous ulcer borders. Ulcer formation can also be depicted if the sores are present in the stomach lining or in the first region of small intestine or if there is unevenness in the surface of the stomach. Usually, the colon haustra lines, which are considered as the silhouette of the endoscopic ulcer images are glabrous and curved in nature. Nonetheless, the existence of sores or ulcers will in turn lead to the viewing of the shape of the silhouettes as deformed. Such unevenness or deformation in the shape is shown by the alteration of the curvature sign, when compared to a normal smooth or even contour of the same curvature sign. Henceforth, the feasible existence of deformation in the shape can be detected by analyzing the contour's curvature of the acquired image.

This particular research paper is organized in the following way:- An over-view of the related work is presented in Section 4. Section 5 and Section 6 gives a concise retrospect on Proposed methodology and Results respectively. Under the proposed methodology, pre-processing, processing and thresholding and grow-cut segmentation are hashed out in particular. Section 5 focuses on the Conclusion.

Related work:

A brief survey of image segmentation techniques are discussed in this section. Image segmentation has various wide applications in the field of image processing. It is widely used for analysis of medical images and for photo editing. Segmentation is defined as the technique where an image is partitioned into various regions on roughly akin basis. Ulcer detection done by the medical experts, is a deeply time engrossed procedure. Hence to resolve this issue, numerous image segmentation techniques have been introduced (Farmer, M.E., A.K. Jain, 2005).

Numerous fully automated segmentation techniques are available in the market, which are perpetually ameliorated. On the contrary, image analysis techniques that are fully automatized in nature, which can be employed without any external control with ensured outcomes generally.

Henceforth segmentation techniques, those which are semi-automatic in nature, and that has the ability of resolving intensely hard segmentation jobs by the application of a small effort on behalf of the user are seemingly gaining popularity (Jianbo Shi and Jitendra Malik, 2000). Recently, numerous powerful methodologies have been propounded for interactive segmentation of images, based on grab-cut, graph cuts (Boykov, Y.,; Baykov, Y., M.P. Jolly, 2001) and random walker (Grady, L., G. Funka-Lea, 2004; Leo Grady, 2006). They have significantly outperformed the older methods both in terms of resulting segmentation quality as well as required user effort.

Boykov and Jolly (2000) implemented graph cut technique for the task of segmenting the organ images. The technique considers the entire image as a graph and the pixels of the image are taken as a graph node. This technique is efficacious for N-dimensional images. Rother *et al.* (2004) has implemented the grab-cut technique by keeping on iterating graph-cut for intermediate steps while doing interactive foreground extraction. After the iterations come to a halt, the results of segmentation can be fine-tuned by mentioning additional seeds, alike the original graph-cut.

The other commonly used methods are:- 1) Texture segmentation, 2) Template matching, 3) Amplitude Thresholding, 4) region- growing partitioning.

An innovative method was propounded by Chen *et al.* (1997), that implements a mask, circular in nature, so that it can mask all the foreground pixels, and eventually executes a threshold computation by the aid of Mann-Whitney test.

Proposed Methodology:

We have used a video endoscope for acquiring the ulcer images and have implemented Matlab software R2010a for processing these endoscopic ulcer images. A considerable number of ulcer images of various sizes have been taken for testing. The propounded scheme ensures effective segmentation of the ulcer images. The segmentation of the endoscopic ulcer images are carried out in the following steps which are as undergoes:-

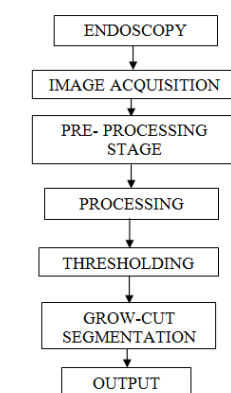


Fig. 1: Phases of Ulcer detection.

Preprocessing :

In this phase, the intensification of the image is done in a way, so that even the details, those which are minute in nature, are ameliorated and eventually, unwanted noises are filtered. Generally used noise filtering techniques are applied, which helps us to procure the feasible results. Enhancement leads to the procurement of more conspicuous edges, image sharpening, and noise reduction, thus reducing the obscuring impression of the image and the possible twisted results of the intervening system. Eventually image partitioning will also be implemented. This ameliorated and refined image aids in edge determination and improves the overall image quality. Edge detection procedure helps us to find the precise position of ulcers. The following steps are carried out in the preprocessing phase:

The procured endoscopic ulcer images are reserved in a MATLAB database and eventually transposed to gray scale image with the dimension of 255*255; 2) images are further processed to filter any presence of noises. 3) Eventually, the high pass filter acts upon the refined image of a higher resolution (noise free) is eventually image sharpening and detection of edges. 4) Then, the

Image Acquisition:

By the help of endoscopy, the ulcer images are acquired and these scanned images are exhibited in 2D matrix where the pixels are considered to be the elements. Such matrices relies on field of view and size of the matrix. MATLAB is implemented to reserve the images and are exhibited in a gray scale with a dimension of 256*256. The intensity of these gray scale images are represented as a number from decimal 0 to 255, where "0" resembles purely "black" and "255" resembles purely "white". Any intermediate values within this scale differs in arduency ranging from black to white.

Endoscopy was carried out on 20 female and 10 male patients, all of them lying between 20 to 60 years. Their endoscopic images procured from their tests were stored in JPEG image formats.

procured image is stacked with the original image for additional refinements.

Noise Removal:

Digital images always suffers from a number of noises. Noise is an outcome of faults in the image procurement phase which results in the pixel values thus affecting the true intensities of the real scenario. One can remove these noises using adaptive filtering, linear filtering or median filtering. In case of linear filtering, Gaussian or averaging filters are implemented to remove the unwanted presence of noises as the pixel's value for this filter is substituted with its local values.

Average filters are implemented for the removal of the pepper and salt noise present in the image. Median filtering is alike an averaging filter, and can be implemented with ease and better results can be procured. In this type of filtering, the pixel values are decided by the pixel values of neighbourhood. Its sensitivity is less when compared to the outliers.

Processing :

Segmentation:

Segmentation of images is a technique for partitioning the image into multiple segments. On the basis of alike properties, partitioning is implemented. Similarities are clumped separately. Segmentation aids in extracting the important image characteristics, from which information can be very easily comprehended. Ulcer detection from endoscopic images is an intriguing task in the sector of medical imaging processing.

Threshold Segmentation:

Threshold segmentation is the most simplest technique, known for partitioning the image into multiple segments. This type of segmentation is used to create binary image from a given gray scale image. In this particular approach, a threshold value is chosen, based on which gray scale images are transformed into binary image format. The selection of the threshold value is of maximum importance in this technique. K- means clustering method and maximum entropy are the commonly used algorithms in this type of segmentation. This concept works on a very simple concept which includes a parameter called θ , known as the threshold value for brightness, is selected and eventually, applied to the input image. Let us say it is applied to image $a[b,c]$ in the following manner:

If $a[b,c] \geq \theta$ $a[b,c] = \text{object} = 1$

Else $a[b,c] = \text{background} = 0$

This design of the algorithm considers the fact that we are we are mainly focussed with the presence of lighter objects on a darker background. For the reverse way, we can implement:-

If $a[b,c] < \theta$ $a[b,c] = \text{object} = 1$

Else $a[b,c] = \text{background} = 0$

We have implemented Otsu's method for thresholding segmentation. Basically, in Otsu's approach, an in-depth search for the threshold that reduces the variance in intra-class, is performed by us, which is known as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = \omega_1(t)\sigma_1^2(t) + \omega_2(t)\sigma_2^2(t)$$

Grow-Cut Segmentation:

Fig. 2: Ulcer Images.

The endoscopic ulcer image segmentation are done by the implementation of a cellular automation technique known as the grow-cut method. In this methodology, the segmentation is initiated by the selection of seed points. The segmentation process operates by implementing a set of user inputs in the form of "object" and "background" brushes for foreground and background. Eventually, the seed pixels and the label strengths are fixed by single pre-defined paint strokes by a set of brush. The incomplete user labelling at the initial level, is often ample to permit the complete segmentation process to be completed in an automatic manner (not compulsorily). When all the pixels in the region of interest are labeled, the algorithm tends to meet, and no labels can be changed by any pixels any further.

The user can monitor the progress and interact at the right time as well as guide the labeling process, if at all there is a necessity, when the cell labels are being calculated. Adding of segmentation constraints in the form of user editing takes place. Each new paint strokes affect the underlying pixel states and hence the automaton evolution is affected as a result. The above proposed method allows acquiring or extracting the region of interest from backgrounds (complex in nature) by the aid of strokes of a paint brush done by the help of a mouse.

Proposed Methodology:

We have implemented Matlab software R2010a for image processing. A considerable number of endoscopic ulcer images of various sizes have been taken for testing. The propounded scheme ensures segmentation and detection. An endoscopic ulcer image is considered in figure 2. Noise filtering technique i.e., median- filtering is implemented on such images containing ulcers. The outcomes are displayed in the figure 3.

In figure 4, a white area is seen, which is an outcome, when thresholding is implemented on the input image. This white area, in particular, is the area with the highest intensity values compared to the threshold (defined). Areas with higher values (more intense in nature), mostly contains ulcer. Hence by applying threshold segmentation, we can easily locate the position of ulcers.

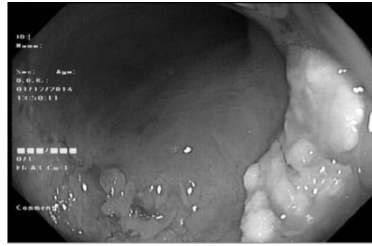


Fig. 3: Outcome of Median Filtering.



Fig. 4: Threshold Segmentation.



Fig. 5: Outcome of Grow Cut Segmentation.

We can observe that the obtained output image in figure 4 is a standard one, but not very much good in quality. It is possible to fine-tune the partitioning outcomes based on the user's input. The following indispensable characteristics of our propounded approach are being reflected:-

- Shows ameliorated, enhanced precision rates.
- Potent in calculating.
- Competitive usability is shown.
- Hale in nature.

The detailed view of the histogram of the ulcer affected area is given below in figure 6:

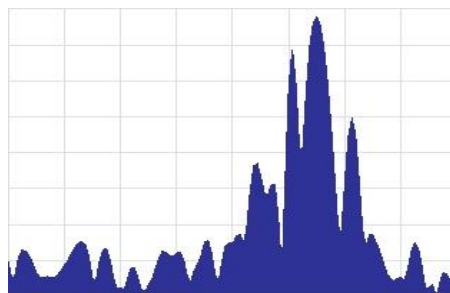


Fig. 6: Histogram of ulcer affected area.

Conclusion:

This experiment was performed to locate the presence of ulcer by implementing medical imaging approaches. Image segmentation is done mainly by a technique based on median filtering and Otsu's threshold segmentation and grow-cut segmentation technique. The propounded approach was tested with

endoscopic ulcer images, thus precisely locating the position and size of ulcers in the images. The ulcer images were procured using endoscopy and eventually were processed by the application of segmentation techniques thus giving more accurate and efficient outcomes when compared to other approaches. The propounded approach is easier to

comprehend and apply. Our suggested system is communicative in nature as the segmentation procedure can be remodelled with each and every looping by the use, thus making it easy to administer and infer. Depending on the results, we can infer that the proposed strategy considerably lessens the applied effort needed for partitioning of image when compared with the existing methodologies such as Graph Cuts and Grab Cut. Our proposed method mixes the features of the above mentioned techniques and relinquishes furthermore dynamic interaction between the algorithm and the user. Both chromatic and textural characteristics are used for developing the map from the ulcer image of the affected patient. A far better segmentation using the Grow cut technique is obtained. We can obtain a far better segmented image using this approach.

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