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Endoscopic Video Pre-Processing using Histogram Equalization and Canny Edge Detection Technique and Hough Transform Technique for Polyp Detection

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Abstract*: Paper An effective image processing approach has been shown to process real time endoscopic videos to support practitioners in taking vital decisions regarding cancer patients. The images are extracted from real time endoscopy videos using the available software and fed into Matlab for image processing, the results of the processed videos are returned back to the host software.

Image processing techniques are used to recognize and enhance the visualization of the polyps present in gastro intestinal tract which help the practitioners in decision making. The intention of the system is to assist the physician or medical practitioner for better visualization and identifying abnormal structures like polyps and bleeding regions during the endoscopic procedures. This proposed system is experimented on the recorded gastrointestinal dataset which contains ten sequence videos with 7894 total frames.

Keywords: Endoscopy, Video Mining, Image Processing

I. INTRODUCTION

Cancer is one of the lethal disease in the world. Among the various types of cancer, gastrointestinal cancer is one such type which may lead to death, unless detected and treated at early stages. Polyps are the deciding elements in concluding the result. Polyps are abnormal tissue growing on the gastrointestinal tract. Not all polyps are hazardous, few may turn into cancerous polyps. Identifying and removing such cancer inducing polys at right stage is essential.

An effective diagnostic measure in gastrointestinal tract is endoscopy, which us an endoscope with a camera and a transmitter which sends video frames. The visual identification of harmful polyps is done by physician and such polyps are removed. Polyps are slightly bulged small tissues appearing similar in color with the surrounding tissues. The Visualization by technicians and physicians is a difficult task due to noise in endoscopy videos.

The quality of endoscopic videos is a big hurdle in detecting harmful polyps is due to noise produced by calibration of camera and low contrast. The objective of this work is to enhance the quality of video by applying pre-processing techniques on source videos like noise filtering and contrast enhancement. This supports the physicians by providing noise free video for better visualization of the data.

II. PRE-PROCESSING

The endoscopic images need to be pre-processed and corrected before feature extraction and analysis. The different types of corrections are Lighting corrections.

A. Contrast Enhancement

Lighting can cause shadows that distracts texture and structure, the uneven distribution of light may give wrong result. Enhancing the Contrast improves the visibility of specified structures in endoscopy frames.

Histogram equalization method is one of the efficient method used to correct the lighting by enhancing the contrast.

Histogram equalization adjusts the intensity values of pixel. The process involves transforming the intensity values of input image so that the histogram of the resultant image matches a stated histogram.

Contrast enhancement is accomplished by carrying out histogram stretching in color space of RGB. The R, G and B histogram intensities are individually stretched. To evade distortion of hue, the contrast enhancement can be done in the HSI color space, earlier computational overhead was related with transformation of color space. For every intensity matrices of 3, lower and upper limits of intensity are derived. The histogram need to be remapped from this range to a new normalized range of 0, 1 to shield the entire range of intensity. Figure 1(a) is the image given as input and Figure 1 (b) is the image after enhancing the contrast.

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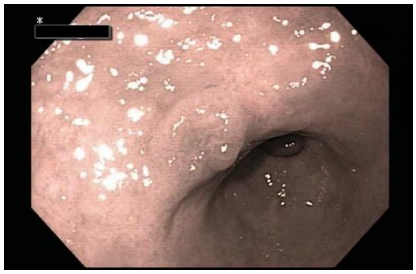

Figure 1 (a) Input frame

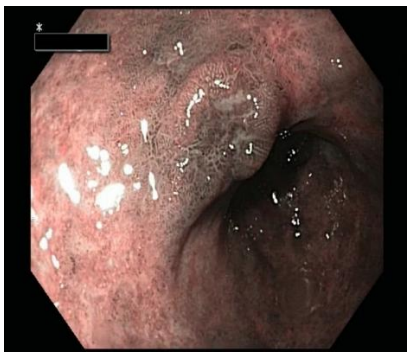

Figure 1(b): contrast enhanced

B. Segmentation

Segmentation is done by discovering edges. The intention is to find all edges of polyp structures present in the endoscopy images and minimizing the incorrect edges, which are generated due to background and noise. This goal is achieved efficiently by canny edge detection algorithm [2]. The techniques like Roberts or Sobel methods can also be used for this process [3]. However, the above algorithms produce more false edges and thus more accurate result yielding procedure is required.

Edge detection procedure is performed on the individual R, G, and B intensity matrices. The yields of the all three individual procedures are aggregated to yield a summed up value. This technique characterizes an active cooperation between performing native RGB edge detection which involves 3-dimensional vectors and performing grey-level edge. After edge detection is completed, a morphological operation is applied to solidify edges. An oval structure is taken to achieve image dilation on the image with edges. The intention of the dilation is to link disjoint edges that stay nearby organized. Figure (a) represents the summing of R, G, and B edges. Figure 2(b) shows the outcome of dilation.

Figure 2 (a) Input image

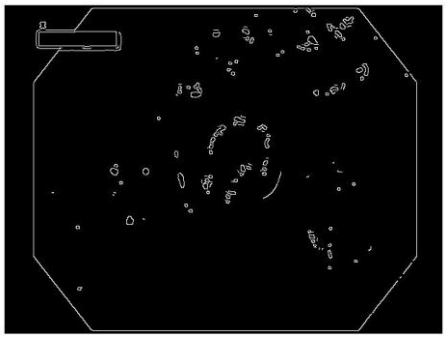

Figure 2(b) Edge image with dilation

The segments of images are identified once dilation is completed. Every region connected of white pixels is a segment. The black colored pixels are part of background and they are not accepted as portion of segment.

III. POLYP IDENTIFICATION

The segments of image are inspected to decide if polyp is present in them or not. The object classification problem requires the structures of every segment of image. Which is extracted and compared with the characteristics of the proved polyps. This approach classify the taken image segment as polyp or non-polyp.

The principal method is to get an entire features of segment. But the efficient method is to extract features which are required for processing. The extracted Features are related with original characteristics a polyp. If feature of the segment fails to be predictable as polyp, then those segment are not consideration and further features are ignored.

The area of segment is the main feature considered from image. The number of pixels constituting the segment other than the number of pixels surrounding the segment is considered as area. It is easier to calculate the number of pixels in the segment than to identify shapes and area calculation. The segments that are below proved threshold are removed as possible polyps. The threshold is specified using actual pixels or as a fraction of total image [6].

The segment's color is additional feature used to conclude. A rectangle shape of size which can cover the segment is used to show location and size of image segment. The rectangle is later used to clarify the region on the taken input color image shown by image segment. The color of segment is taken as the median pixel intensity for the region, the intention is to differentiate polyp shaped objects from black body cavities. The tissue wall opening yield sharp inclines and are easily different from dark pixels of region. The darker median intensity segments which are darker than minimum threshold are not considered in further investigations.

The next feature for consideration is object shape. As polyps generally have oval shape, the elliptical shape of the object is expected. The techniques for identifying shapes are determined. The various object shape identifying techniques are available to find geometric shapes. Shapes, Hough Transform is one collective method used in finding regular geometric shapes, the shapes like line, circle, oval, etc. The Hough transform technique converts the image from spatial domain to a space of parameter, where analysis of shapes are done as points.

There are multiple approaches to avoid computation complexity while detecting the oval or elliptical shaped objects. The most popular among is randomized Hough Transform technique [4], here the subset of the spatial data is examined. One more approach is to split the five dimension parameter space of ellipse to several sub spaces of lesser dimension [5]. The above said techniques have reduced the Hough transform computation complexity, but are not compatible for real time use.

The shape detection approach is not very much effective in real time with the help of conventional algorithms, the feature extraction may be achieved with an assumption as all the objects are elliptical in shape.

The first and second instants of inertia of the objects are determined, the polyp are explained as an ellipse with a guess. The assumption can be acceptable since polyps shape are elliptical. Using the color and size criteria the non-polyps are discarded from being analyzed.

The first order instance of object relate to centroid and second order instance relates to inertial ellipse of object.

The polyps are generally curvy, if a segment has inertial ellipse with eccentricity of higher scale is not happen to be polyp. Another feature tested is the eccentricity of a segment. The image segments having high eccentricity are left out. The remaining segments of images can positively considered as polyps.

Figure 3(a) Input image

Figure 3(b) contrast enhanced image

Figure 3(a) shows the best suitable ellipse for the polyps using inertial ellipse. The ellipse matches the shape of the polyp, and explains the polyp in relationships of the parameters of the ellipse [6]. To show the exact position of polyp, ellipse will be drawn over contrast enhanced endoscopic image, Figure 3(b).

IV. CONCLUSIONS

The video dataset used is taken for research paper and cited [1] .The research work tries to pre-process the endoscopic images using several pre-processing techniques for contrast enhancement and also tries to identify the polyp in the image using Hough transform technique, the contrast enhancement techniques and edge detection technique has less computational complexity and can be applied for real time denoising of endoscopy videos. The Hough transform is not preferred for real time object detection, but based on the assumption of only elliptical polyps in videos, the research work has been carried out to detect the polyps in endoscopic videos.

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Nagesh B S holds a Master degree in computer applications from Kuvempu university and pursuing research under VTU, Belagavi, at RNSIT, Bengaluru. Has published 4 research papers in reputed international journals. The main areas of research are Video Mining, Machine Learning, Artificial Intelligence, etc.

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