COMPUTER AIDED AUTOMATIC DETECTION OF POLYP FOR COLON TUMOR

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ABSTRACT

Colorectal cancer is one of the types of cancer caused in the region of colon. The women affected by this colon cancer in high rate compared to men with the mortality reaching to about 50% of the incidence. The major precursor of colon cancer is colorectal polyps. If we left the polyp untreated colon cancer may develop. Colon capsule endoscopy is a minimally and safe invasive examination procedure, a small size of capsule is ingested to the patient through on board digital cameras of capsule the intestine images are obtained. The video sequence is then analyzed for the presence of polyps. We propose pixel level image fusion algorithm to fuse the contents of consequence two images from the video sequence. Then, the ANFIS classifier is used to segment the colon tumor from the fused image. This segmented tumor image is compared with ground truth image to analyze its performance in terms of sensitivity and specificity. The performance results are compared with other state of arts.

***Keywords**: **ANFIS classifier, capsule colon endoscopy (CCE), colorectal cancer, computer aided detection, image diagnosis, polyp deduction**.*

I. INTRODUCTION

Colorectal cancer is the second leading cause of cancer in women and the third most common cause in men [18], than lung cancer. The major risk of colon cancer is reduced by primary detection and removal of colonic polyps. Colorectal cancer develops inside the region of colon and rectum. The essential precursors of colon cancer are colorectal polyps. Benign stage of tumors may develop as malignant tumor if we left the polyp untreated. Colon capsule endoscopy (CCE) [1], [8], [9], [12], [17] is a feasible alternative to conventional examination methods, such as the colonoscopy or computed tomography (CT) colonography [10]. In CCE, a small size imaging device in the form of capsule, is ingested by the patient. As the capsule moves via the patient’s gastrointestinal tract, the on board digital cameras record the surrounding images of intestine. After recording, the digital images are transmitted to a recording device wirelessly taken by the patient. Per second 2 to 30 or more frames are captured from the capsule depending on the model, with the low frame rate devices being prevalent currently. The presence of polyps is analyzed after the complete video sequences are recorded. Analysis of all frames manually is such burdensome tasks because thousands of frames are collected from single patient. To reduce such difficult task an automated procedures is used for detecting polyps in the frames. Thus, an efficient algorithm is used for detecting the polyp accurately with high specificity to reduce the manual analysis of the frames.

II. RELATED WORK

The proposed algorithm of polyp detection is depending on retrieving certain geometric details from the frames captured by the colon capsule endoscopic camera. It is not a new approach, as it has been noticed before that the polyps can be characterized as protrusions from the surrounding mucosal tissue [11], [20] which was used in CT colonography and in the analysis of conventional colonoscopy videos [4], [5], [20]. Computation of protrusion measure is one of the natural process but the detection of polyp frame measure is difficult task. However, this leads to an issue that was also observed in the above mentioned works. The major problem is distinguishing between the polyp protrusions and the numerous folds of mucosal tissue. These issues can be alleviated by some segmentation of images that helps the computation of the protrusion measures easier [6], which is what we do in this work as well. A particular choice of a measure of protrusion is of crucial importance. Most of the authors have proposed the use of principal curvatures and the similar quantities, such as curvedness and the shape index or mean curvatures and the Gaussian [11]. The main drawback of such approaches is that the curvature computation is depends on differentiation of the image, which must be approximated by finite differences.

III. PROPOSED METHOD

In proposed method, ANFIS classifier is used to deduct the polyp or not. During diagnose the polyp get differentiated as whether it is malignant or benign tumor.

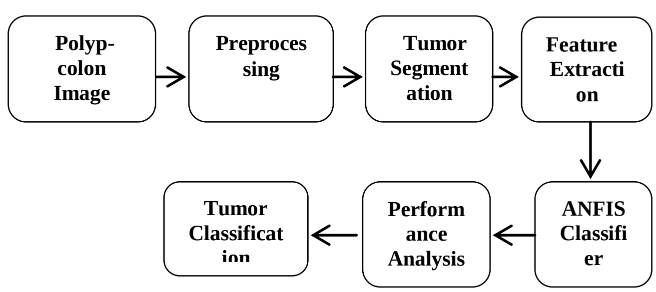

Fig.1.Block Diagram

3.1. Preprocessing

The median filter is applied over the colon image to remove the noises. The median filter works on the principle of selecting and replacing, median value among the selected 3*3 pixel window in the colon image.

3.2 Tumor segmentation

Colon tumor is segmented from the preprocessed colon images after enhancement.segementation is done to separate the image into two or more sub modules. Global thresholding technique is used for segmentation.

3.3. Feature extraction

3.3.1. Local Binary Pattern (LBP)

The local binary pattern (LBP) feature has emerged as a silver lining in the field of texture classification and retrieval. For texture classification LBP are converted to a rotational in-variant version. Various extensions of the LBP, such as LBP variance with local patterns with joint distribution of Gaussian mixtures, completed LBPs, dominant LBPs, global matching, etc., are used in proposed method of rotational invariant texture classification.

Nowadays, imaging technologies have permitted researchers to collect a large number of digital images in the image retrieval domain. Developing an automatic system for search, retrieval, or classification of images from their databases is a very important issue. The local binary pattern (LBP) is one of the most used texture descriptors in image retrieval analysis.

The colon image is divided into several regions from which the LBP feature distributions are extracted and concatenated into an enhanced feature vector to be used as an image feature descriptor.

3.3.2. Local Ternary Pattern (LTP)

LBP is extended to a three-valued code called the LTP, in which gray values in the zone of width $\pm t$ around g_c are quantized to zero, those above (g_c + t) are quantized to +1, and those below (g_c- t) are quantized to -1, i.e., $f_2(x)$ indicator is replaced with three-valued function and the binary LBP code is replaced by a ternary LTP code, as shown in the figure

$$\hat{f}_1(x, g_c, t) = \begin{vmatrix} +1, x \geq g_c + t \\ 0, |x - g_c| < t \\ -1, x \geq g_c - t \end{vmatrix} x = g_p \qquad (1)$$

The standard local binary pattern (LBP) and local ternary pattern (LTP) encode the relationship between the referenced pixel and its surrounding neighbours by computing gray-level difference.

3.4 Classifier

The extracted features are trained using ANFIS classifier in training mode. In the same way, the features are extracted from test colon image and these features are classified with trained features to classify the colon cells in to benign and malignant. The ANFIS architecture is shown in Figure 3. The circular nodes in the figure are fixed nodes and the square nodes have parameters to be trained. For an ANFIS adaptive network with fixed premise parameters, the output is linear in the consequent parameters. The total parameter can be categorized into three:

S= set of total parameters

S_1= set of premise parameters

S_2= set of consequent parameters

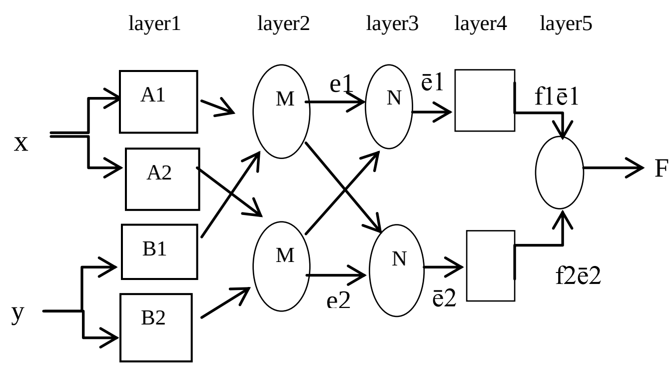

Fig.2. ANFIS architecture employed in proposed method

ANFIS employs a 2-pass supervised learning algorithm, which consists of, a Forward Pass and a Backward Pass. The steepest descent algorithm is used along with the least squares algorithm to adapt to the parameters in this ANFIS algorithm

3.4.1. The Forward Pass

Here S_1 is fixed and S_2 is estimated using a Least Squares algorithm. The procedure is as follows:

Step 1: Feed the input vector

Step 2: at each layer and at each node output are computed

Step 3: Repeat for all data →A until y is produced

Step 4: Find the parameters in S_2 using Least Squares

Step 5: Each training pair error are calculated

3.4.2. The Backward Pass

Here S_2 is fixed and S_1 is estimated using back propagation. The parameters in S_1 are updated by back propagation for given fixed values of S_1 and these parameters are assured to be the global optimal point.

IV. EXPERIMENTAL RESULTS

In this section, the statistical analysis result is provided according to the test methodology outlined in section III.

Colon image is collected from the capsule colon endoscopy. Original colon image is converted into gray scale. The noise gets removed by using median filter. Query image is splited into many region from which the feature of local binary pattern are extracted which is shown in fig 3.

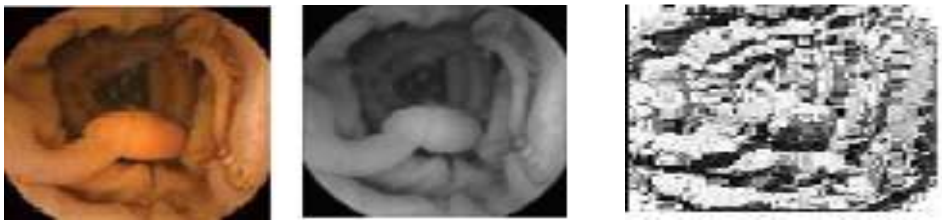

Fig.3. (a) Test colon image (b) Median filtered image (c) Extracted Local Binary pattern

By replacing the local binary pattern into three valued as (-1,0,1) using equ (1) local ternary pattern image get obtained.

Fig.4. (a), (b) Extracted local ternary pattern (c) polyp identified image

Polyp is identified by using the ANFIS classifier algorithm. Fig.4.shows the malignant colon tumor region with the accuracy of 96.7%.Then proposed result is compared with ground truth image which is shown in fig.5

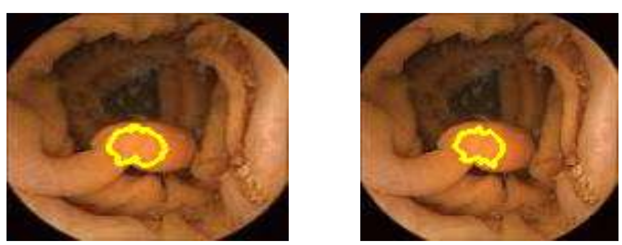

Fig.5. (a).Ground truth image (b).Proposed segmentation result

In our testing method, the target is set to achieve the specificity at 95%.In conventional method the sensitivity and specificity at 81.25% and 93.27% have obtained respectively is shown in table .2.

Performance Parameters	**Experimental Results**
Sensitivity	95.1%
Specificity	98.4%
Positive Predictive value	42.9%
Negative Predictive value	97.9%
Accuracy	96.5%

Table.1. Performance Analysis

Methodology	**Sensitivity**	**Specificity**
Proposed Methodology	95.1%	98.4%
Conventional Methodology	81.25%	93.47%

Table.2. Performance Comparison

ANFIS classifier is used in all data set with the appropriate threshold value the specificity of 98.4% is obtained. With the same specificity level, the sensitivity of 98.4% is achieved in similar polyp is shown in table 1.

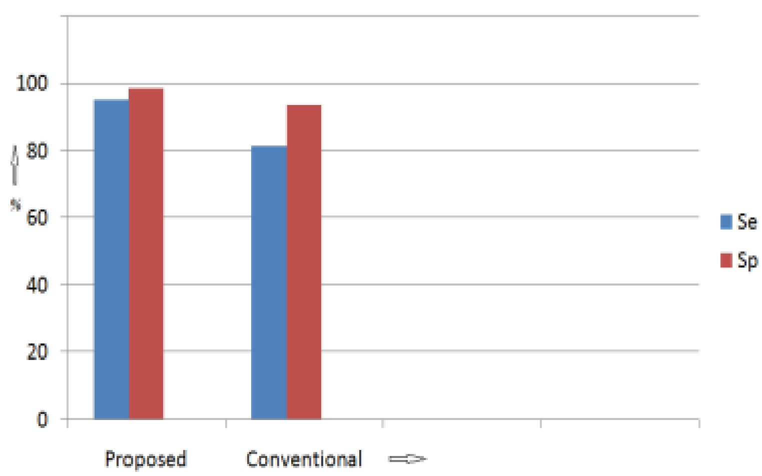

Fig.6. Performance comparison Chart

The difference between sensitivity and specificity range of conventional and proposed method is shown in the fig.6. The accuracy level of 96.5% is obtained.

V. DISCUSSION

In this paper, automated polyp detection of colon polyp in image retrieved from the colon capsule endoscopy. The deduction of polyp is a challenging factor due to the presence of many folds in mucosal tissues, vignetting, bubbles and trash liquids.to overcome all these issues and the detection of polyp automatically obtained using ANFIS classifier. High range of Sensitivity per polyp with similar important of the high sensitivity range per patient also achieved through the statistical analysis of the algorithm i.e., reduced false positive polyp detection of per patient.

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