Discriminative Pattern Measure and Classification of Hook Worm WCE Images

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Abstract

Wireless capsule endoscopy (WCE) has become a widely used diagnostic technique to examine several life time diseases and disorders. Careful microscopic examination of WCE images is the only way to effective detection of hook worm. Automatic hookworm detection is a challenging task due to poor quality of images, presence of extraneous matters, complex structure of gastrointestinal, and diverse appearances in terms of color and texture. To discriminate the unique visual features for different components of gastrointestinal, the histogram of average intensity is proposed to represent their properties. This paper shows that a properly selected subset of patterns encoded in LTP forms along with wavelet transform based frequency domain parameters extraction is an efficient and robust texture description which can achieve better classification rates in comparison with the existing methods. In order to deal with the problem of imbalance data, Rusboost is deployed to classify WCE images. Experiments on a diverse and large scale dataset with large set of WCE images demonstrate that the proposed approach achieves a promising performance and outperforms the stateof-the-art methods. Moreover, the high sensitivity in detecting hookworms indicates the potential of our approach for future clinical application. Computer simulation involved the following tests: comparing the impact of dimension on the system before and after the influence of local ternary pattern, comparing the performance of the proposed algorithms with ANN classifier on subimages and whole images, and comparing the results of some of the existing systems with the proposed system.

Keywords:*Hook worm detection (HWD), Classification, Feature extraction, Segmentation etc.*

I. INTRODUCTION.

WIRELESS capsule endoscopy (WCE) is pill-shaped device which are often used to take samples of small bowel bleeding for routinelaboratory examination. This can be easily swallowed by the any patient, and then this capsule travels into stomach along esophagus and then passes through pylorus, duodenum, small intestine and colon. Finally, it reaches at the rectum and excretes from the anus. The WCE captures more number of RGB color images for every second. It is greatly required as an monitoring approaches to design and implement hook worm detection for endoscopists. Hookworm is a kind of small tubular structure with different appearances from mucosa and bubble edges, usually having grayish white or pinkish semi-transparent body. Hook form is often difficult to diagnose since the precise exploration of hook worm is still difficult task to accomplish.

In recent years, research on WCE becomes a hot topic. Computer aided detection systems based on different techniques have been extensively conducted, which bring endoscopists great convenience and efficiency. Comprehensive surveys on WCE research can be found in [14] and [15], which summarize the latest development from different aspects. The research on WCE covers a wide range of topics, including image enhancement [16], tissue segmentation or matching [3], [17], video segmentation [18], motility event detection [19], video summarization [20], and so on. A majority of the research on WCE focuses on pathological abnormality detection, which is the focus of this work.

In section-IIexplains the basic theory of color conversion and feature attribute model and its applications in hook worm detection.In section-III discuss about proposed CADsystem implementation.In section-IV comparative analyzes and statistical approaches was compared.In section V conclusion and future work was discussed.

II. AUTOMATED HOOK WORM DETECTION

The proposed method is based on the theory that a nonlinear system can be modeled by multiple piecewise linearization systems. Every small part of the edges can be seemed as straight lines (linear lines). Therefore, the whole edges are the combination of small straight lines. First, for each binary tubular region, the Canny detector is adopted to detect the edges of tubular structure in the gray image. Short edges with small gaps are connected together to form a long edge by performing edge linking. The isolated dots are treated as noises and removed.

2.1 HOOK WORM:

Properties of Hookworms The characteristics of hookworms are quite different from bleeding, ulcer and polyps. The hookworm is a kind of small tubular structure with different intensities from mucosa and bubble edges, which has two major peculiarities.

1) Tubular structure: The hookworms have obvious boundary than other tubular structures. The edges of hookworm bodies usually in the form of nearly parallel curves.

2) Intensity property: The color of hookworms is usually grayish white or pinkish semi-transparent. Sometimes the hookworms have reddish or darker color compared to surrounding mucosa.

2.2PREPROCESSING

A Lab color space is a color-opponent space with dimension L for lightness and a and b for the color-opponent dimensions, based on nonlinearly compressed CIE XYZ color space coordinates. CIE L*a*b* (CIELAB) is the most complete color space specified by the International Commission on Illumination. All of the color information is in the 'a*' and 'b*' layers are used for color based segmentations as shown in Fig 1.

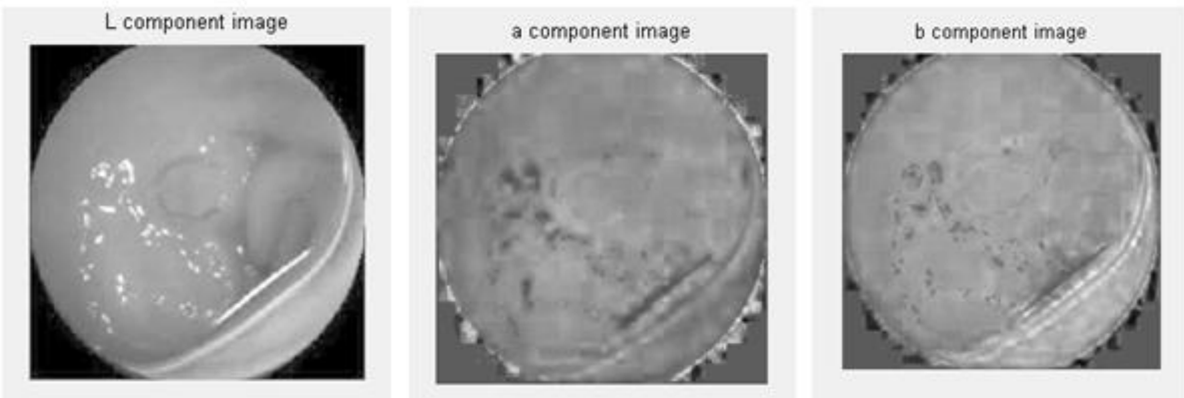

*Fig 1 L*a*b preprocessed images*

2.3 MULTI FRACTAL ANALYZES AND ROI SEGMENTATION ALGORITHM

Results of many observations and practical explorations show that for many objects and phenomena occurring in nature relations between their numerical characteristics satisfy the power law, which states that the estimated quantity (for example the area of square) is proportional to the side size in a power. For many geometric objects we observe a power law with integer degree. At the same time for real objects very often such a power is not integer but fractional.

There are various types of fractal dimensions. In practice the class of so called box-computing (boxcounting) dimensions (e.g. capacity dimension) is widely used.

In this work we consider two methods for image segmentation: fractal signature and multifractal analysis. The first method is based on the construction of the grey level function graphics for a greyscale image, which is a surface in 3- dimensiomal Euclidean space. For this surface we can calculate a characteristic called fractal signature and the Minkovsky dimension, which are simple related. The segmentation may be performed by partitioning of the image into cells and calculation fractal signature (or Minkovsky dimension) with the following marking the cells by a color in accordance with the obtained values as shown in Fig 2.

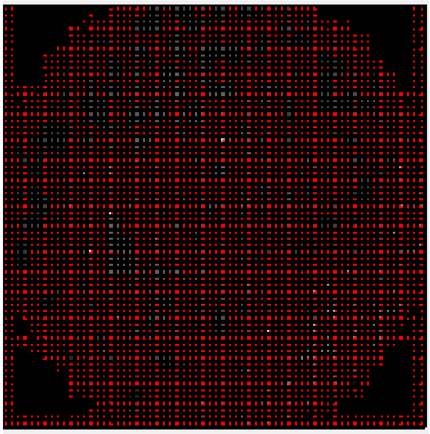

Fig 2 Multi fractional dimensional analyzes

Fractal Signature Method The idea of the method is to calculate fractal dimension of the surface formed by the graphic of the grey level function for a given image. Hence multifractal approach in addition to calculation of multifractal spectrum allows us to perform segmentation easily. In this case we obtain a set of segmented images.

LBP:

LBP is a simple and efficient gray scale feature descriptor of an image which describes the spatial structure of the local image texture as shown in Fig 3.

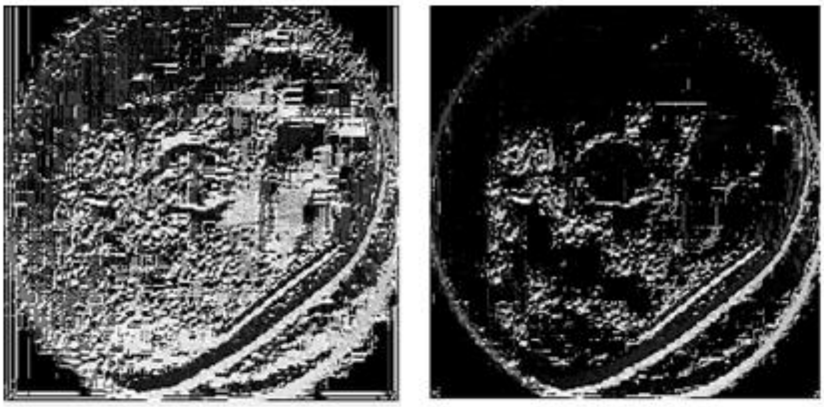

Fig 3 texture classification output

A LBP code is computed by

i) Splitting the image in to 3×3 block
ii) Comparing the center pixel of 3×3 block with the neighborhood pixel LBP Code is generated using following equation:

$$LBP_{P,R} = \sum_{p=0}^{p=p-1} x(g_{n-} g_{c}).2^{p}, \quad (1)$$

$$S(t) = \begin{cases} 1, t \geq 0 \\ 0, t < 0 \end{cases} \quad (2)$$

Where,
g_n-Gray value of a neighborhood pixel.
g_c- Gr ay value of a center pixel.
P-Total number of involved neighbors.
R-Radius of the neighborhood.
t= (g_n - g_c)

2.4 FEATURE EXTRACTION

Feature extraction in image processing is a technique of redefining a large set of redundant data into a set of features of reduced dimension. Transforming the input data into the set of features is called *feature extraction*. To extend this goal with fully automated which can detect Leukemia cells more accurately which has three basic features. Color and texture cues represented as global features are crucial for intestine content detection. In the cases of bleeding, bile and fecal detection, color cue isimportant because bleeding usually tends to be red while bile and fecal matters appear to be green. Texture features used for WCE pathological abnormality detection include LBP.

```
LBP GLCM features
   17.6411    0.4526    0.0953   -0.0667
   14.8999    0.5530    0.1891   -0.0555
   14.8999    0.5530    0.1891   -0.0555

LTPU GLCM features
   11.6617    0.4822    0.0653    0.0635
    9.5999    0.5499    0.1247    0.0646
    9.5999    0.5499    0.1247    0.0646

LTPL GLCM features
   11.6617    0.4822    0.0653    0.0635
    9.5999    0.5499    0.1247    0.0646
    9.5999    0.5499    0.1247    0.0646
```

Fig 4 Texture feature

2.4.1 Texture features.

The Gray Level Coocurrence Matrix (GLCM) method is a way of extractingsecond order statistical texture features.

- **Energy**
- **Contrast**
- **Entropy**
- **Correlation**

2.4.2 Shape features.
The shape of the nucleus, accordingto haematologists, is an essential feature for discrimination. Region- and boundary-based shape features are extracted for shape analysis of the nucleus.

```
Data base Shape feaure values
            area: [8x1 double]
       maxLength: [8x1 double]
       minLength: [8x1 double]
       perimeter: [8x1 double]
    Eccentricity: [8x1 double]
          extent: [8x1 double]
    EquivDiameter: [8x1 double]
```

Fig 5 Shape feature

III. RESULTS AND COMPARISON

To evaluate the performance of the proposed automatic hookworm detection, WCE images of are collected from the West China Hospital as the dataset. Each WCE image is a 24 bit RGB color image with the resolution of 256×256 pixels. All images are collected by the OMOM R WCE, which has been widely used in hospitals in China and other countries. Since the hookworms usually live in the upper small intestine, the images from pylorus to the end of videos are included in the experiments. Totally, there are few WCE images in the dataset, and on average each patient has around several images. To the best of our knowledge, this dataset is one of the largest datasets for automatic disease detection for WCE images. Unlike other works that select only a few hundreds to thousands of WCE images for evaluation, in this work, the whole dataset is used.

Comparison of results of proposed methods and edge detection method in MATLAB showed that for 4 classes of high resolution biomedical preparation images fractal and multifractal methods are seemed to be more reliable.

3.1 PERFORMANCE MEASURE

3.1.1 MSE measure

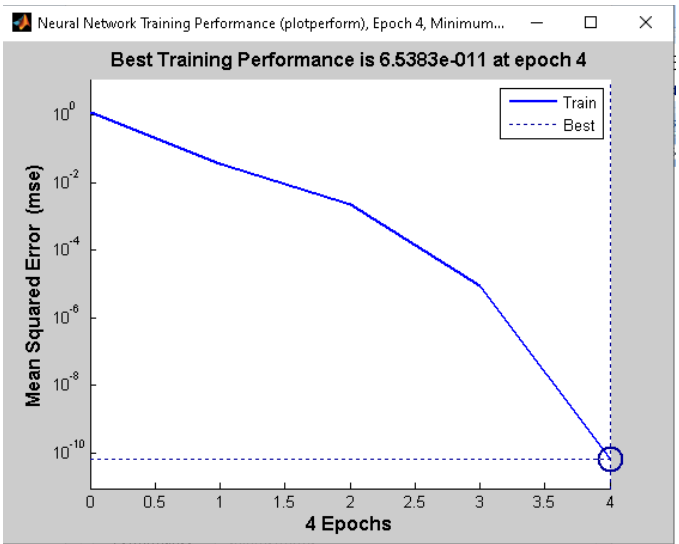

Fig 6 Training performance measure

IV CONLCUSION

In this paper, a novel deep hookworm detection framework is proposed for WCE images to model the visual appearance and tubular regions of hookworms, which contains an edge extraction network and a hookworm classification network. Image segmentation may be obtained as an additional result of fractal or multifractal analysis. These methods allow us to calculate numerical characteristics that are input data for a classification problem. Moreover, the partitioning an image into parts in accordance with these data leads to easy segmentation algorithm.

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