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A Survey on WCE Abnormality Detection Methods

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Abstract: This Wireless capsule endoscopy (WCE) can directly take digital images in the gastrointestinal tract of a patient. It has opened a new chapter in small intestine examination. The major problem associated with this technology is that too many images need to be manually examined by clinician or doctor. Therefore, it is crucial to design an automatic computer aided system to assist clinicians to analyze abnormal images. This paper describes different WCE abnormality detection methods. It provides an insight on different feature extraction methods and classification strategies used for WCE abnormality detection.
Keywords: Wireless capsule endoscopy, Abnormality detection, Computer aided system Feature extraction, Classification strategies

I. INTRODUCTION

Wireless Capsule Endoscopy involves swallowing a small capsule, which contains a camera, battery, light source and transmitter. The camera takes two pictures every second for eight hours, transmitting images to a data recorder about the size of a portable CD player that patients wear around the waist. Capsule endoscopy helps to diagnosing gastrointestinal abnormalities in the small bowel such as bleeding, ulcer, polyp chronic abdominal pain, and chronic diarrhea. Once a WCE capsule is swallowed, it passes through the gastrointestinal (GI) tract and wirelessly taking the colour images for an average duration of 8 h. These images are then transmitted wirelessly to a data-recording device attached to the patient's waist. Then a clinician or doctor reviews the images and makes diagnostic decisions. The video reviewing and interpretation of the whole approximate 50, 000 images for each patient take about 2 h for experienced clinician .The abnormal images usually occupy only less than 5% of the whole ones. Moreover, spatial characteristics of abnormal images such as shape, texture, size, and the contrast with their surrounding vary, so it may be difficult for clinicians to reliably detect abnormality in all circumstances .Therefore, it is crucial to design an automatic computer-aided system to assist clinicians to analyse abnormal images.

II. LITERATURE SURVEY

Much work has already been undertaken on automatic abnormal image detection in WCE videos. The common diseases in the GI tract are typically bleeding, polyp, and ulcer. So survey was done among different proposals and the survey paper includes survey among different methods for WCE abnormality detection .

Yixuan Yuan et al.[1] proposed a computer aided automatic multiple abnormality WCE image detection scheme, namely, saliency and adaptive locality constrained linear coding algorithm, by considering the local coding bases adaptively and the saliency information about the images. It uses a method, namely, SALLC for WCE image classification, which considers the saliency and local information about patch feature simultaneously. Different from the existing approaches that treat each local feature equally, this encoding method incorporates the saliency constraints to emphasize the important features of the images. Moreover, instead of calculating the response of each descriptor to a fixed number of code words, SALLC method projects each descriptor into an adaptive determined number of coding bases, which is calculated based on the distances between the feature and the visual words.

Yixuan Yuan et al. [2] proposed a two-staged fully automated computer-aided detection system to detect ulcer from WCE images. In the first stage, an effective saliency detection method based on multi-level super pixel representation is carried out to outline the ulcer candidates. To find the salient regions, first segment the image into multi-level superpixel segmentations. Each level corresponds to different initial region sizes of the super pixels. Then the corresponding saliency according to the colour and texture features in superpixel region of each level is evaluated. Finally fuse the saliency maps from all levels together to obtain the final saliency map. In the second stage, apply the obtained saliency map to better encode the image features for the ulcer image recognition tasks. Ulcer mainly corresponds to the saliency region, so saliency max-pooling method integrated with the Locality-constrained Linear Coding (LLC) method is used for characterization of the images.

Yanan Fu et al. [3] proposed a new method which is able to detect bleeding regions from WCE video more effectively and efficiently. Because edge pixels and bleeding pixels share similar hue, traditional algorithms often mistake edge pixels for bleeding pixels. Here the method first detects the edge pixels, and then use the morphological dilation to locate and remove the edge regions. Instead of processing each pixel or dividing the image uniformly, pixels are grouped adaptively based on cooler and location through superpixel segmentation. Each image can be represented by hundreds of super pixels to reduce the computational complexity. For each superpixel, the feature is defined using the red ratio in RGB cool space. Finally, to classify the bleeding and non bleeding super pixels support vector machine (SVM) is used.

W. Sylvia Lilly Jaborandi et al. [4] proposed a work focused on analysis of capsule endoscopy images for Crohn's disease lesion. The normal and the lesion images are classified based upon the size, and the severity of the lesion and any surrounding inflammation. For this classification long range features are necessary. Here color, edge and texture features were extracted for the Capsule endoscopy images. The color and the edge features are extracted by the MPEG-7 Dominant Colour Descriptor and MPEG-7 Edge histogram Descriptor. The texture features are based on the MPEG-7 texture descriptor. The MPEG-7 texture descriptor makes use of Gabor filters of different scales and orientations. The texture feature alone was not sufficiently accurate for the analysis of Cohn’s disease. A new method is introduced in this paper that uses Local Binary Pattern (LBP) to extract the textural features. LBP is a local texture descriptor to describe the intensity distribution. Texture contents of an image region are characterized by the distribution of Local binary pattern. These features are trained, tested and classified using SVM classifier in order to have supervised learning model.

Miguel Tavares Coimbra et al. [5] makes use of MPEG-7 standard, which specifically defines a series of visual descriptors that can be used to classify the content of video images. The most popular usage of these descriptors is for video indexing where values are extracted from the query image and then matched to the corresponding descriptors of images contained in a database. Our situation has some similarities: we have a database of manually annotated video sequences obtained from endoscopic capsule exams, and we want to automatically annotate new exams.

Baopu Li et al. [6] addresses the problem of automatic recognition of tumour for WCE images. Candidate colour texture feature that integrates uniform local binary pattern and wavelet is proposed to characterize WCE images. The proposed features are invariant to illumination change and describe multi resolution characteristics of WCE images. Two feature selection approaches based on support vector machine, sequential forward floating selection and recursive feature elimination, are further employed to refine the proposed features for improving the detection accuracy.

Alexis Eid et al. [7] propose a texture extraction method, based on the Discrete Curvelet Transform, which is a multi-resolution analysis tool that performs wavelet analysis in the 2-D domain. The selected color space is Cyborg, because previous work on WCE images has indicated that it provides better results than other commonly used color spaces. First, images are decomposed in a number of DCT subbands of different scale and direction. Then, the lacunarity index of selected subbands is calculated and a feature vector is formed. The classification is performed by a Support Vector Machine (SVM) using a dataset of real patient data acquired from hospitals.

Nawarathna et al.[8] propose a new multi-texture analysis method that effectively discerns images showing mucosal abnormalities from the ones without any abnormality since most abnormalities in endoscopy images have textures that are clearly distinguishable from normal textures using an advanced image texture analysis method. A “texton histogram” of an image block is used as features in this method. Distribution of different “textons” representing various textures in an endoscopy image is captured by histogram. The textons are representative response vectors of an application of a combination of Leung and Malik (LM) filter bank and a set of Local Binary Patterns on the image.

Yixuan Yuan and Max [9] proposed an innovative algorithm based on the integration of the Bag of Features (BoF) method and the saliency map is proposed to detect polyps from the WCE images. The algorithm constitutes of four steps. In the first step, by applying the BoF method, the visual words of all images are calculated by inputting the extracted Scale Invariant Feature Transformation (SIFT) feature vectors to the K-means clustering procedure. Then the saliency and non-saliency maps of the WCE images are separately calculated. Following that, the histogram of the visual words of each image is calculated by integrating histograms in both saliency and non-saliency maps with various weights to represent the WCE image. Finally, polyp classification of the WCE images is conducted by Support Vector Machine (SVM) classifier.

Yixuan Yuan et al.[10] propose a new feature integrating the Gabor filter and Monogenic-Local Binary Pattern (M-LBP) methods in color components for polyp detection. The new feature not only can represent shape and edge information under multi-resolution, but also preserve color information. The proposed method is consisting of the following steps: first step is to transform the original WCE images into different color space and extract the corresponding Gabor responses of the color components. Next the M-LBP descriptors applied on the resulting Gabor responses are concatenated together to characterize the images. Finally Linear Discriminant Analysis (LDA) to reduce feature dimensions is applied.

Xiao Wu et al. [11] proposed a work to comprehensively explore the automatic hookworm detection for WCE images. To capture the properties of hookworms, the multi scale dual matched filter is first applied to detect the location of tubular structure. Then a

Piecewise parallel region detection method is proposed to identify the potential regions having different hookworm bodies. To discriminate the unique visual features for different components of gastrointestinal, the histogram of average intensity is proposed to represent their properties. In order to deal with the problem of imbalance data, Rusboost is deployed to classify WCE images.

Yixuan Yuan et al. [12] propose an improved bag of feature (BoF) method to assist classification of polyps in WCE images. Instead of utilizing a single scale-invariant feature transform (SIFT) feature in the traditional BoF method, extract different textural features from the neighbourhoods of the key points and integrate them together as synthetic descriptors to carry out classification tasks. Specifically, studies carried out on influence of the number of visual words, the patch size and different classification methods in terms of classification performance.

Xiao Jia et al. [13] propose a new method for GI bleeding detection that can automatically and hierarchically learn high-level features via a deep neural network. The CNN has recently drawn great attention to the topic of “deep learning” within the computer vision field and been proved to have remarkable advancement not only in classification tasks of natural images but also in biomedical applications, such as cervical cell segmentation and mitosis detection.

A. K. Kundu et al. [14] development of computer aided automatic bleeding detection schemes is described. To investigate bleeding, the analysis of WCE image frames is carried out in normalized RGB (rgb) color space as human perception of bleeding is associated with different shades of red and rgb overcomes some of the drawbacks of conventional RGB color space. In the proposed method at first, the WCE image frame is segmented based on different ranges of r-values. Then for a certain level of r-value, the variation in g plane is presented with the help of histogram. Features are extracted from the proposed r versus g plane histograms. For the purpose of classification, KNN classifier is employed.

Xiao Jia et al. [15] present an automated bleeding detection strategy that first discriminate bleeding frames from the normal ones, with further segmentation of the bleeding regions using pattern recognition approaches. The proposed method is then adapted to a MapReduce framework to achieve distributed processing, which dramatically reduces the computing time. MapReduce is a programming model that serves in a massively parallel manner to support large datasets processing applications. It is originally proposed by Google for the ease of large scale web search tasks. The MapReduce framework expresses the computation as two functions: a map function that process a key/value pair to generate a set of intermediate key/value pairs; and a reduce function that merges all intermediate values associated with the same key.

TABLE I
COMPARISON OF DIFFERENT WCE ABNORMALITY DETECTION METHODS

Sl.no	Method	Accuracy(%)	Advantages	Disadvantages
1	Saliency and adaptive locality constrained linear coding [1]	88.61%	High classification performance, Focus multiple abnormalities	Slower
2	Saliency based method [2]	92.65%	Outline abnormal region correctly and compactly	Require large amount of data sets
3	Super pixel segmentation [3]	N/A	Influence of edge Pixels removed	Fail to detect image with poor illumination and minor angiodysplasia regions
4	MPEG-7 descriptor [4][5]	N/A	Generic nature	Classification results are not satisfactory
5	Local binary pattern and wavelet transform [6]	92.4%	High accuracy	Time consuming
6	Discrete Curvelet	86.5%	Efficient	Complex in nature

	transform [7]			
7	Bag of features [9] [12]	92%	Superior discriminative ability	Processing time high
8	Deep convolutional network [13]	N/A	Improved performance	Require large training set

III.CONCLUSIONS

Distinguishing abnormal images from normal ones in WCE video is a difficult task for doctors and clinicians. This manual reviewing task may take an average of 2hr per patient, which limit its general application and incurs a considerable amount of healthcare cost. In this paper, different types of computer detection system to classify WCE image automatically are addressed. This paper highlight different feature extraction methods and classification strategies for WCE abnormality detection.

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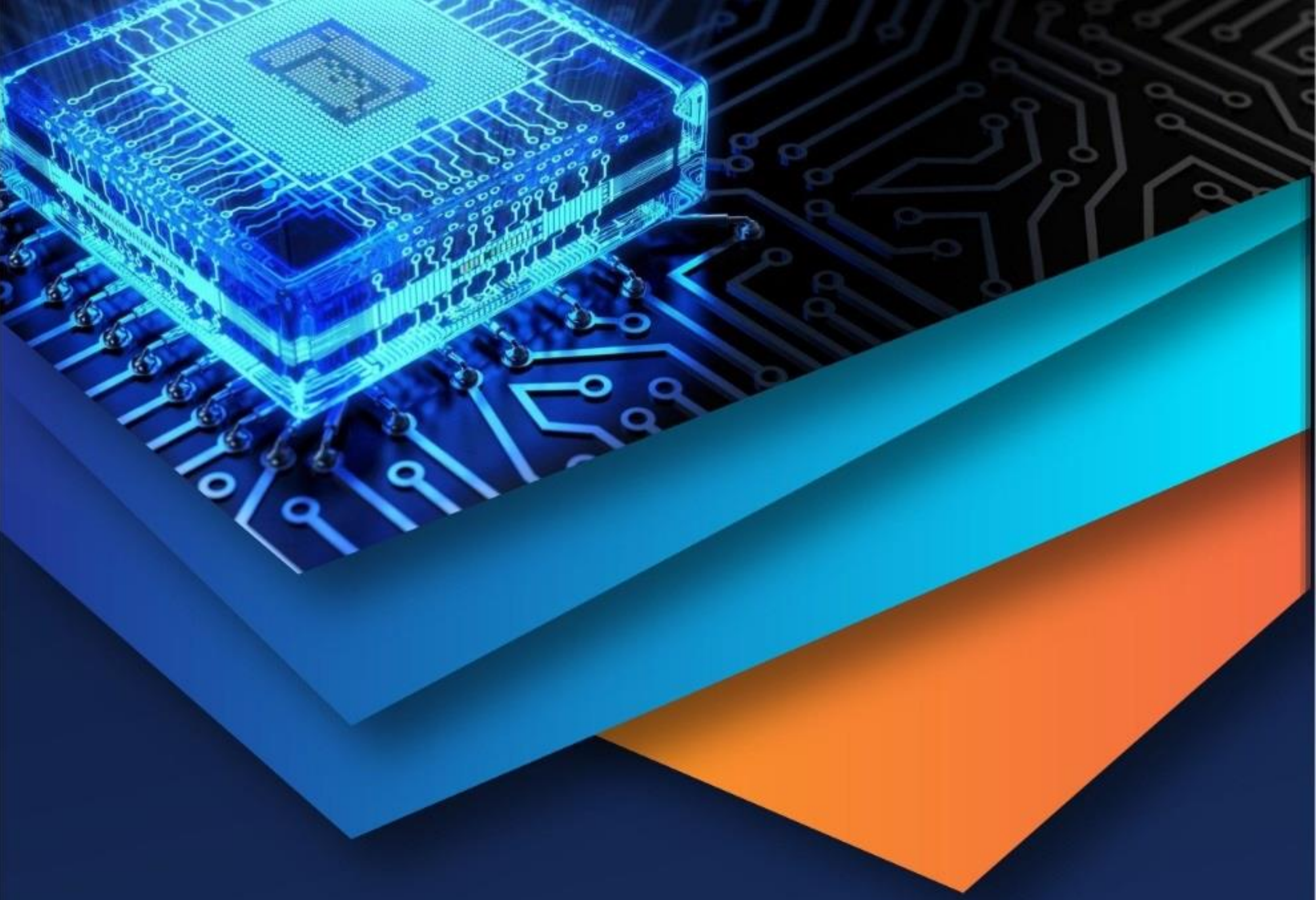

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