Feature Selection and Classification of Ulcerated Lesions Using Statistical Analysis for WCE Images

Shipra Suman 1,*, Fawnizu Azmadi Hussin 1, Aamir Saeed Malik 1, Shiaw Hooi Ho 2, Ida Hilmi 2, Alex Hwong-Ruey Leow 2 and Khean-Lee Goh 2

1 Center for Intelligent Signal & Imaging Research, Universiti Teknologi PETRONAS, Seri Iskandar 32610, Malaysia; fawnizu@utp.edu.my (F.A.H.); aamir_saeed@utp.edu.my (A.S.M.)
2 Department of Medicine, University of Malaya Medical Center, Kuala Lumpur 50603, Malaysia; shooiho@yahoo.com (S.H.H.); i_hilmi@um.edu.my (I.H.); alexleow@gmail.com (A.H.-R.L.); klgoh56@gmail.com (K.-L.G.)

* Correspondence: suman.shipra@ieee.org; Tel.: +60-165-445-748

Received: 29 July 2017; Accepted: 18 September 2017; Published: 24 October 2017

Abstract: Wireless capsule endoscopy (WCE) is a technology developed to inspect the whole gastrointestinal tract (especially the small bowel area that is unreachable using the traditional endoscopy procedure) for various abnormalities in a non-invasive manner. However, visualization of a massive number of images is a very time-consuming and tedious task for physicians (prone to human error). Thus, an automatic scheme for lesion detection in WCE videos is a potential solution to alleviate this problem. In this work, a novel statistical approach was chosen for differentiating ulcer and non-ulcer pixels using various color spaces (or more specifically using relevant color bands). The chosen feature vector was used to compute the performance metrics using SVM with grid search method for maximum efficiency. The experimental results and analysis showed that the proposed algorithm was robust in detecting ulcers. The performance in terms of accuracy, sensitivity, and specificity are 97.89%, 96.22%, and 95.09%, respectively, which is promising.

Keywords: wireless capsule endoscopy; feature selection; color space selection; statistical analysis; support vector machine; grid search; overlapping area; classification

1. Introduction

Gastrointestinal tract (GIT) diseases, such as ulcer, bleeding, Crohn’s disease, cancer or chronic diarrhea are common nowadays. Bleeding and ulcer are some common lesions which affect the small and large bowel. In the United States, approximately 1.6 million Americans currently are currently suffering from inflammatory bowel disease (IBD), representing an increase of about 200,000 since 2011. There are approximately 70,000 new cases of IBD diagnosed each year, and there may be as many as 80,000 children who are suffering from Crohn’s disease (CD) or ulcerative colitis (UC) currently. Additionally, as illustrated reported in the first paper of this issue [1], the incidence number of occurrences of IBD is increasing worldwide [2]. The growth of IBD cases in newly-industrialized countries has paralleled its growth on par with that of the Western world 30 to 40 years ago. Genetic and environmental studies performed in these countries may provide new clues to the pathogenesis of IBD. However, it adds another layer of complexity since risk factors and gene-environment interactions may vary by continents and ethnicities [3]. Traditional endoscopy has been adopted for many years in order to diagnose abnormalities of GIT, whereby a physician controls a flexible endoscope to examine the lower and upper parts of GIT. This technique is limited to inspecting bowel of average length 7–8 m. It imposes high level of discomfort on the patient as well.

Wireless capsule endoscopy (WCE) [4,5] is a recent technology introduced by Given Imaging Ltd. (Yokne’am Illit, Israel) to visualize the entire GIT painlessly. It offers an efficient and comfortable