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Generic Feature Learning for Wireless Capsule Endoscopy Analysis

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Wireless capsule endoscopy, Deep learning, Feature learning, Motility analysis

1. Intoduction

Wireless Capsule Endoscopy (WCE) is a technique designed to facilitate inner-visualization of the entire gastrointestinal tract. It was developed in the mid-1990s and published in 2000 [1]. The invention is based on a capsule that can be swallowed, and is equipped with a light source, camera, lens, radio transmitter and battery. After being swallowed, the capsule is propelled by peristalsis along all gastrointestinal (GI) tract, thereby allowing for full visualization of it from inside without pain or sedation.

This technology was warmly welcomed by the gastroenterology community, because it allows minimally invasive inspections, even of those parts of the intestine that are not accessible by traditional means. Nowadays, despite our inability to control the motion and position of the capsule in the GI tract, the device is considered to perform the gold-standard technique for the diagnosis of bleeding [2, 3], and it is becoming a very popular research tool for possible future diagnosis of particular diseases such as tumors [4, 5], chronic abdominal pain [6] and motility disorders [7].

The main drawbacks with WCE-based diagnosis are the duration of the videos produced and the complexity of the images. A normal small intestine video can last up to 8 hours. This means that a single video can contain up to $57,600$ images, if a 2-frames-per-second capsule is used (this number is even larger with higher frame-rate capsules). All these frames are presented with highly variable camera orientation and perspective, since the device moves freely inside the GI tract. Moreover, sometimes the scene can be fully, or partially, obscured by the intestinal content such as bile or food being digested. Figure 1 allows us to fully appreciate the complexity of the endoluminal scene. This scene complexity together with the length of a single WCE study make proper video analysis by physicians a difficult and tedious task. A recent study presented in the American Journal of Gastroneterology [8] showed that the performance achieved in visual analysis by physicians is far from perfect.

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