

Automated Cleanliness Scoring and Digestive Content Segmentation for Capsule Endoscopy

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Abstract. Accurate evaluation of capsule endoscopy videos plays a crucial role in diagnosing gastrointestinal disorders. One important aspect is the assessment of the cleansing quality, which indicates the visibility of the gastrointestinal mucosa during the examination. In this study, we propose a novel method for assigning a cleansing score to capsule endoscopy videos. Moreover, our system proposes a segmentation masks for each frame, highlighting the regions of the image that are not visible. This additional information aids in the interpretation and analysis of the videos, enabling more accurate diagnoses and improved patient care.

Keywords. capsule endoscopy, cleansing, segmentation, digestive content, video quality

1. Introduction

Performing a capsule endoscopy involves several important steps to ensure a successful examination. The process begins with bowel preparation, which is crucial for optimal visualization of the gastrointestinal tract. Bowel preparation typically involves a restricted diet for a day or two before the procedure, which may include avoiding solid foods and consuming only clear liquids. Additionally, patients may be required to take laxatives or other medications to cleanse the bowels and remove any residual debris or stool [1]. In this work, we present a threefold approach to enhance the quality of annotation. Firstly, we aim to simplify the annotation process by converting the problem into a binary decision for annotators, focusing on specific regions within an image. Secondly, we propose an automated method for generating segmentation masks, which effectively highlight regions in an image that may be occluded by digestive content. Lastly, we introduce a cleanliness score that incorporates various factors, providing a comprehensive assessment of video cleanliness. This score considers multiple aspects and serves as a concise summary of the overall cleanliness level observed in the video. By implementing these

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three strategies, we aim to streamline the annotation process, enhance annotation accuracy in occluded regions, and provide a comprehensive cleanliness evaluation metric for videos.

2. Methods

Instead of manually segmenting digestive content masks, a laborious task, we leveraged labels provided by physicians who annotated 2176 random patches of 64x64-pixel images as 1 (bad visibility) or 0 (good visibility) from 18 different videos. The labels were assigned based on whether the presence of digestive content would obstruct any potential pathology. Using this data, we trained a ResNet50 classifier with 14 videos (1696 patches) and we used 4 different videos (480 patches) for validation. To obtain the segmentation masks, we employed a sliding window approach with 32 pixels of overlap on each frame. This allowed us to compute the percentage of visible mucosa per frame using the segmentation masks. After applying this process to all images in a test video, we generated a plot illustrating the visibility level in each video segment. This plot provides valuable insights into the level of visible mucosa throughout the video.

3. Results

The classifier achieved an accuracy of 90.2% and an AUC of 95.7% on the classification task. In Figure 1(a), we present three examples of segmentation masks generated through the previously described procedure. Patches with predicted values exceeding 0.7 were classified as positive. Figure 1(b) illustrates the percentage of visible mucosa in blue, along with a moving average for 100 frames in orange. Additionally, we have overlaid a discretized scale from 0 to 3 on this plot, following score proposed by [2], to provide a clearer representation of the scores. This visualization helps in understanding the variations and trends in the scores throughout the video.

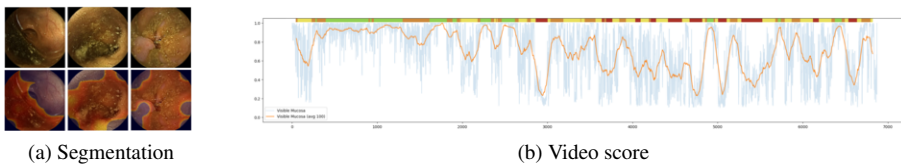


Figure 1. Output of the proposed system.

References

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