Automatic Detection of Angiectasia: Evaluation of Deep Learning and Handcrafted Approaches*

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Angiectasia, formerly called angiodysplasia, is one of the most frequent vascular lesions and often the cause of gastrointestinal bleedings. Medical specialists assessing videos of examinations reach a detection performance of 16% for the detection of bleeding to 69% for the detection of angiectasia. In this paper, we present several machine-learning-based approaches for angiectasia detection in wireless video capsule endoscopy images. The most promising results for pixel-wise localization and frame-wise detection are obtained by the proposed deep learning approach using generative adversarial networks (GANs) with a sensitivity of 88% and specificity of 99.9% for pixel-wise localization and a sensitivity of 98% and a specificity of 100% for frame-wise detection, which fits the requirements for automatic angiectasia detection in real clinical settings.

Superficial vascular lesion called angiectasia represent one of the most common source of bleeding in the small bowel and are therefore important to be detected. The most common procedure to detect angiectasia is video capsule endoscopy (VCE). State-of-the-art software from the industry is able to reach an automatic detection sensitivity of 41% and a specificity of 67%. For a clinical scenario, both, sensitivity and specificity should be as close as possible to 100%, but at least larger than 85% [1]. Automatic detection of angiectasia is not very well researched, and there are only a few publications on the topic using saliency detection [2]. Therefore, in this work, we test different machine learning approaches to tackle automatic angiectasia detection in VCE videos.

Pixel-wise segmentation/localization approaches. The presented localization approach is able to pixel accurate mark the angiectasia in the given frame based on a GAN architecture initially developed for the retinal vessel segmentation in fundoscopic images called V-GAN. We added an additional output layer to the generator network that implements an activation layer with step function in order to generate the binary segmentation output.

Frame-wise detection approaches. These approaches are designed to detect if there is angiectasia or not on a frame level. We proposed various configurations of our main methods [3]. For the global-features-based methods, we extracted handcrafted global features describing the whole image properties, e.g., texture, color distribution, etc. For the deep-features-based approaches we used different deep learning (DL) architectures to extract either the features directly or to classify the images and using the whole range of concepts and their probabilities as input for the classifiers. The architectures that we used are ResNet50, VGG19, and InceptionV3. For the final classification we used Random Tree, Random Forrest and Logistic Model Tree classifiers. The GAN detection approach utilizes a simple threshold activation function, which takes the number of positively marked pixels in the frame as an input. All the experiments were performed using a publicly available GIANA 2017 dataset [4] consists of training and test frame sets (1200 frames in total).

Experimental studies showed the sensitivity of 88% and specificity of 99.9% for the GAN localization approach, which are above the 85% margin recommended for a real clinical settings. The processing speed is 1.5 frames per second. All the tested frame-wise detection approaches outperform the ZeroR baseline and the best working GAN approach achieves superior frame-wise detection performance with a sensitivity of 98% and a specificity of 100%.

In conclusion, we presented and compared machine- and DL-based methods for automatic detection of angiectasia on a pixel- and frame-wise level. We demonstrated the capability of our proposed deep learning approach to reach and exceed clinical requirements. For the future, we plan to improve the processing speed and extend the method to other pathologies.

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