Evaluation of Computer-aided Classification of Colorectal Polyps based on PIVI Initiative

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***Abstract*— Accurate prediction of polyp histology during colonoscopy allows endoscopists to implement resect-and -discard or diagnose-to-leave strategies for diminutive colorectal polyps (≤ 5mm) and make on-site recommendation for the next surveillance interval, saving time and cost. This study presents the evaluation of a computer-aided (CAD) method transferring low-level Convolutional Neural Network (CNN) features learned from non-medical domain for classification of colorectal polyps evaluated based on Preservation and Incorporation of Valuable Endoscopic Innovations (PIVI) initiative, of which the objectives are to identify clinical importance relating to endoscopic technologies. Two preliminary experiments were conducted according to the two statements of PIVI initiative and the proposed CAD method resulted in great potential for real-time endoscopic assessment use.**

I. Introduction

The burden and cost of overuse surveillance colonoscopy are significant [1]. To avoid excessive operation and time-consuming pathology evaluations, resect-and-discard and diagnose-to-leave strategies were proposed. An American Society for Gastrointestinal Endoscopy (ASGE) program called PIVI initiative has established a threshold to determine whether new colonoscopy technologies are appropriate for incorporating into use of these strategies [2].

II. Methods

A CAD model similar to [3] was constructed to classify endoscopic polyp images taken under narrowband imaging into hyperplastic and adenomatous. The first n levels of CNN features were transferred from knowledge learnt in the ImageNet challenge (ILSVRC [4]), which aimed to classify 1.2 million images into 1000 classes. A feature vector was generated by summing the intensity of the transferred CNN features and a standard support vector machine (SVM) classifier was trained for polyp classification.

III. Experiments

Two evaluation tests were conducted based on the recommendation of PIVI. Task I was designed for evaluation of PIVI statement 1, where a total of 155 hyperplastic and 430 adenomatous images were extracted from 45 hyperplastic and 121 adenomatous polyps, including those ≤ 5mm to be resected-and-discarded and those > 5mm. Task II was designed for evaluation of PIVI statement 2, where a total of 52 hyperplastic and 89 adenomatous images were extracted from 16 hyperplastic and 28 adenomatous rectosigmoid polyps ≤ 5mm. The histology predictions with high confidence (the prediction probability score was > 90%) were compared with results obtained from pathological reports. In each task, the leave-one-polyp-out strategy was used for evaluation, where one image for the tested polyp was randomly selected while images of the remaining polyps were used for training. All polyps were tested. A total of 10 experiments were conducted for each task.

IV. Results and Conclusion

Transferring the first 3 and 2 levels of CNN features followed by an RBF-kernel SVM performed best for task I and task II, respectively. An average of 28.2% and 49.3% of predictions were accounted high confidence for Task I and Task II, respectively. The average accuracy of Task I is 86.6% with a 95% confidence interval (CI) of 83.1% to 89.5%. The average negative predictive value of Task II is 87.4% with a 95% CI of 80.3% to 90.1%. When compared with the recommendation of PIVI, which requires ≥ 90% agreement for Task I and ≥ 90% negative predictive value for Task II, the proposed method shows high potential to be used for real-time prediction of polyp histology during colonoscopy. Further training of the classifier with a larger amount of data should be evaluated in future.

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References

[1] R. E. Schoen, P. F. Pinsky, J. L. Weissfeld, L. A. Yokochi, D. J. Reding, R. B. Hayes, et al., "Utilization of surveillance colonoscopy in community practice," Gastroenterology, vol. 138, pp. 73-81, 2010.

[2] D. K. Rex, C. Kahi, M. O'Brien, T. Levin, H. Pohl, A. Rastogi, et al., "The American Society for Gastrointestinal Endoscopy PIVI (Preservation and Incorporation of Valuable Endoscopic Innovations) on real-time endoscopic assessment of the histology of diminutive colorectal polyps," Gastrointestinal endoscopy, vol. 73, pp. 419-422, 2011.

[3] R. Zhang, Y. Zheng, W. C. T. Mak, R. Yu, S. H. Wong, J. Lau, et al., "Automatic Detection and Classification of Colorectal Polyps by Transferring Low-level CNN Features from Non-Medical Domain," IEEE Journal of Biomedical and Health Informatics, 2016.

[4] O. Russakovsky, J. Deng, H. Su, J. Krause, S. Satheesh, S. Ma, et al., "Imagenet large scale visual recognition challenge," International Journal of Computer Vision, pp. 1-42, Dec 2015.

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