SSK17-02

Ensemble Deep Learning for the Improvement of the Performance of Computer-aided Detection of Polyps in CT Colonography

Wednesday, Nov. 30 10:40AM - 10:50AM Room: S404AB

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PURPOSE

To develop and evaluate an ensemble deep learning (EDL) in the improvement of the detection performance of computer-aided detection (CADe) of polyps in CT colonography.

METHOD AND MATERIALS

A total of 154 CT colonography (CTC) cases were sampled from a large multi-center CTC screening trial. A deep convolutional neural network (DCNN) that had been pre-trained with millions of natural non-medical images was re-trained to identify polyps by use of virtual endoluminal (VE) images of the polyp candidates that were obtained by application of our existing CADe system to these CTC cases. Seven different types of rendering were generated for each of the VE images. An EDL was developed by first re-training seven DCNNs on the seven types of rendered VE images, and then combine them by a super-learner algorithm using a random forest classifier as the meta-classifier. The resulting EDL was reviewed the VE images of the polyp candidates to determine the final detected polyps. For evaluation, the 154 CTC cases were divided randomly into a training and a test dataset. The test set contained 107 biopsy-confirmed adenomas and carcinomas ≥6mm in size: 69 were ≥10 mm and 38 were 6–9 mm in size. The performance of the EDL on the test dataset was evaluated by sensitivity analysis compared with that of the baseline CADe and a single DCNN with McNemar test.

RESULTS

At 4.3 FPs per patient, the per-polyp sensitives of CADe, DL, and EDL were 84.1%, 91.6%, and 93.5%, respectively, for polyps ≥6 mm; and 84.1%, 97.1%, and 97.1%, respectively, for polyps ≥10 mm. The sensitivity difference between CADe and EDL was statistically significant (for polyps ≥6 mm, p=0.002; for polyps ≥10 mm, p=0.03). The CADe scheme yielded 93.5% of the polyps at 12.7 FP detections per patient on average. With the application of EDL, the number of FP detections was reduced to 4.3 per patient (66% reduction) at the same sensitivity.

CONCLUSION

EDL can significantly improve the performance of CADe of polyps in CTC.

CLINICAL RELEVANCE/APPLICATION

The EDL-based CAD could be used to provide a high detection accuracy of polyps in screening population.