Polyp Enhancement Scheme for Improved Detection of Colonic Polyps in CT Colonography

Ender Konukoglu, Burak Acar, David Paik, Christopher F. Beaulieu, Sandy Napel

Purpose: To develop a polyp enhancement scheme that would improve the performance of the majority of previously proposed CAD algorithm for CTC that rely on the assumption that polyps are approximately spherical protruding structures.

Method: The underlying idea is to use the Level-Set (LS) based interface (colon wall) propagation techniques to suppress the polyp necks while inflating the polyp apex. LS based interface propagation along the surface normal direction according to a nonlinear speed function sensitive to the surface differential characteristics is used. A nonlinear function of the surface principal curvatures is proposed for speed calculations. The method is evaluated in conjunction with the previously proposed Surface Normal Overlap (SNO) algorithm on a polyp-rich real patient dataset acquired from a 56 year-old female (supine position, 4 slice multidetector CT, 2.5 mm sections, 1.25 mm intervals) containing a total of 47 polyps. For the size categories of > 5 mm and > 8 mm, there were 31 and 7 polyps, respectively, all confirmed by fiber-optic colonoscopy. We compared the detection performance of SNO alone and SNO after polyp enhancement with level-sets (PELS), using the FROC curves. The gold standard was set by an expert radiologist who examined the 3D data and marked the polyp centers using a custom-built software.

Results: Both the SNO and PELS+SNO reached 7/7 sensitivity for polyps >8mm in diameter. SNO alone had 107 false positives (FPs) where as PELS+SNO had 24 FPs. They had 8 versus 20 FPs at 6/7 sensitivity for the same set of polyps. Considering all polyps with diameter >5mm, SNO reached 17/31 sensitivity, where as PELS+SNO detected 23 out of 31. For the sake of comparison, PELS+SNO had 49 FPs at 17/31 sensitivity as compared to the 368 FPs of SNO alone.

Conclusion: Built-in polyp enhancement is a new approach to CAD for CTC. The proposed PELS algorithm had promising results in terms of boosting the performance of SNO polyp detector. It is expected to enhance the performance of most of the other detectors as well. Larger datasets are required for more reliable assessment of PELS.