TITLE: COMPUTER AIDED DETECTION OF POLYPS IN VIRTUAL COLONOSCOPY USING 3D HEAT DIFFUSION FIELDS

AUTHOR LIST: [1]Ender Konukoglu, [1]Burak Acar, [2]David Paik, [2]Christopher F. Beaulieu, [2]Sandy Napel

INSTITUTION: [1]Bogazici University, EE Dept., Istanbul, Turkey; [2]Stanford University, Dept. of Radiology, Stanford, CA

PURPOSE: Our goal is to develop a Computer Aided Detection (CAD) algorithm with high sensitivity and low false positive (FP) rate to detect colonic polyps in CTC data. Our approach is to utilize the concept of heat diffusion to be able to eliminate non-polyp protruding structures like haustral folds without sacrificing polyp sensitivity of CAD.

METHODS: The underlying idea is to assume the colon lumen to be a heat source initially and to track the diffusing heat fronts looking for special patterns of diffusion that mark the polyps. The diffusion pattern is captured with a vector field (V) called the heat diffusion field (HDF). The isotropic heat diffusion is manipulated via iso-temperature surfaces' (initially the colon wall itself) characteristics such that V has a relatively symmetric sink (the divergence minimum marked by a star in Figure 1) in the center of polyps. Such points are detected on a vector field sink symmetry parameter (FA) field. The colon wall structure around the detected points (hits) is examined to eliminate non-polyp points that may occur at the junctions of folds, etc. and that result symmetric sinks of V mimicking polyps. This is done by sending out probes in various directions in 3D from the hits and computing a second parameter (P) as the number of directions along which an air voxel was encountered within a certain distance. Lower the FA and higher the P are, more likely the hit is a true polyp. We evaluated the algorithm using a polyp-rich 3D CTC dataset from a 56 year-old female (supine position, 4 slice multi-detector CT, 2.5 mm sections, 1.25 mm intervals) having 7 polyps with a diameter > 8mm confirmed by fiber-optic colonoscopy.

RESULTS: We applied a low FA threshold for initial detection that resulted in 422 hits followed by evaluating the post-processing using FROC analysis of P. The results are 6 FPs at 6/7 sensitivity and 29 FPs at 7/7 sensitivity. The lowest ranking polyp (10.4mm diameter) was located at the junction of folds as shown in Figure 2. This caused its low P score.

CONCLUSION: Nonlinearly manipulated 3D heat diffusion patterns within the colon tissue exhibit correlation with the colon wall. Their analysis is a promising approach for CAD in CTC, esp. in discriminating haustral folds from polyps. Further research is needed to optimize the parameters for clinically relevant polyp sizes and to evaluate the method on a larger dataset.

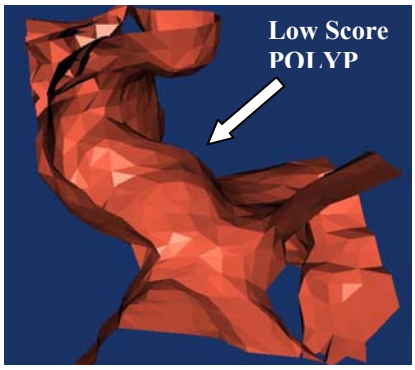


**Figure 2** The lowest scoring polyp with 10.4mm diameter located at the junction of folds.

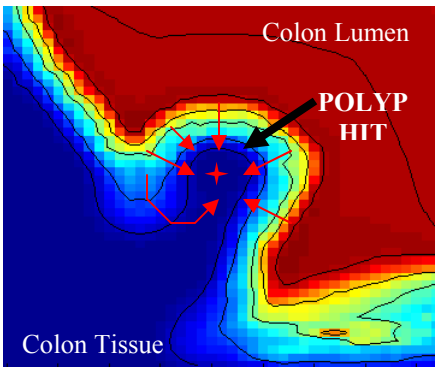


**Figure 1** The 3D heat distribution on the central slice of a 8.9mm polyp. The color code runs from red (hot) to blue (cold). Note the nonlinear behavior (due to increased diffusion) at the base of the polyp.