# Hamilton–Jacobi procedure to Pareto depth analysis for fast colonic polyp detection

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## Talk Abstract

Colon cancer is a common type of cancer and a leading cause of cancer death worldwide. Its early detection increases the survival rate, and this correlates with the accurate detection of colonic polyps. These are lesions (fleshy growth) that can be visualized *in vivo*, by medical doctors, during a colonoscopy exam, for instance, either with a conventional colonoscopy or a wireless capsule endoscocope. Here it is described a novel method for fast colonic polyp detection, presented in [1], for *in vivo* images of conventional colonoscopy. Firstly, polyp detection is formulated as a similarity-based anomaly detection method (see [2]), based on multiple objectives, which formally involves Pareto depth analysis (also called as non-dominated sorting). The chosen objectives rely on the main physical and visible differences, observed in colonoscopy images, between regions containing colonic polyps and the surrounding normal mucosa (see also [3]). These differences are defined primarily according to the contrast in shape, texture, and color. Secondly, as Pareto depth analysis is of combinatorial nature and is costly to compute, it is replaced by a fast algorithm that approximates the sorting in the continuum limit. The fast algorithm involves numerical solutions to a particular Hamilton–Jacobi equation (see [4, 5]). The proposed similarity-based anomaly detection is thus reformulated into a fast polyp detection method. Several experiments were conducted with a proprietary medical data set, containing 1640 instances of 41 different colonic polyps. The results show that the proposed Hamilton–Jacobi approach to non-dominated

sorting speeds up the non-dominated sorting procedure, by more than 500%, and, when compared with other existing methods, it is also faster without lost of accuracy. Moreover, the tests conducted for streaming data, reveal an outstanding performance, in terms of sensitivity and specificity, as well as, a fast auto-adaptability, which demonstrate the power of the proposed approach towards a real-time and automatic detection, undoubtedly beneficial for clinical practice.

**Keywords:** image processing, multi-criteria optimization, Hamilton–Jacobi equation, colonic polyp.

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