

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Computer Aided Diagnosis for Virtual Endoscopy

By

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Endoscopic procedures sometimes have serious side effects such as perforation, infection, and hemorrhage. Virtual endoscopic visualization avoids the risks associated with real endoscopy, and when used prior to an actual endoscopic procedure can minimize procedural difficulties and decrease the rate of morbidity. In this thesis, we have proposed novel algorithms to improve and enhance virtual endoscopy applications.

Effective colonoscopic screening for polyps with optical or virtual means requires adequate visualization of the entire colon surface. We have utilized a simulation method to estimate what percentage of the colon surface is missed in the *optical colonoscopy* (OC) and *virtual colonoscopy* (VC). We have adopted a partial volume model in the segmentation and digital cleansing to handle the partial volume effect. The topological noise is automatically removed from the segmentation result by a 3D region growing based algorithm using the concept of a *simple point*. Most common methods in virtual endoscopy simulate the behavior of a real endoscope, which is not the most efficient technique in many endoscopy procedures. We present a conformal colon flattening technique which virtually unfolds the colon, allowing physicians to inspect its surface and detect polyps on a single 2D image. Volume Rendering can provide high-quality virtual endoscopic views for virtual endoscopy applications. However, it is still a challenge to render contemporary clinical data sets in real-time. We present a GPU-based object-order ray-casting algorithm to render large volumetric data sets. We also exploit the cooperation and trade-off between the GPU and the CPU to obtain further acceleration. We further present a novel pipeline for CAD of colonic polyps by integrating texture and shape analysis with volume rendering and conformal colon flattening. Our system detects 100% of the adenomatous polyps, and yields a low FP rate. The results are easily integrated into a VC system, which allows physicians to perform their diagnoses more accurately and efficiently.

All presented techniques have been tested with a number of data sets to show their feasibility. In this thesis, we focus on CT colon data sets although our techniques could be used with a variety of other human organs, such as blood vessels and bladder.

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