Project Summary
Advances in video technology are being incorporated into today’s healthcare practice. For example, various types of endoscopes are used for colonoscopy, upper gastrointestinal endoscopy, enteroscopy, bronchoscopy, and cystoscopy. In addition, a rapidly expanding number of formerly open surgical procedures now are being converted to endoscopic procedures including resection of gallbladders, retrieval of donor kidneys, resection of tumors of colon and pancreas, correction of hiatal hernias, coronary artery bypass grafting and minimal invasive neurosurgeries (i.e., video endoscopic neurosurgery). During an endoscopic procedure, a tiny video camera at the tip of the endoscope generates a video signal of the interior of the human body, for example, the internal mucosa of the colon. Despite a large body of knowledge in medical image analysis, video data generated during these procedures are not systematically captured for real-time or post-procedure reviews and analyses. Video data are recorded occasionally to magnetic video-tapes (i.e., VHS). No hardware and software tools have been developed to capture, analyze, and provide user-friendly and efficient access to the medical, scientific, or educational content on such videos. Aim: This project aims to develop an Endoscopic Multimedia Information System (EMIS) to capture high quality endoscopy videos, analyze the captured videos, and provide efficient access to the valuable content of these videos. Intellectual Merits: Images of endoscopy videos significantly differ from medical still images as studied in the literature of medical image processing. Hence, new algorithms and tools are needed. The project has the following intellectual merits. (1) New capturing system for endoscopy videos: The capturing system is designed such that it ensures patient’s privacy and is non-disruptive to endoscopic procedures and non-restrictive to a particular endoscope vendor. The practicality of the capturing system will be assessed and improved during the course of the project. (2) New algorithms for automatic classification of informative and non-informative frames: Our classification is unique in the following aspects. First, obvious unimportant images are discarded using our non-informative frame detection technique that does not require any reference image to determine the quality of the image. Second, the technique does not need any predefined parameters or thresholds. (3) New algorithms for automatic content analysis for protruding lesions such as polyps: The algorithms process only informative images to determine whether the image has any protruding lesions. Many protruding lesions are clustered together. A new region segmentation technique that can identify isolated lesions will be developed first. To handle clustered lesions, algorithms using a region pattern graph that captures important characteristics of relevant regions will be developed. The anticipated theoretical advancement are new analysis techniques for image quality and image segmentation, and detection techniques for protruding lesions under changes in lighting conditions and camera movements. Broad Impacts: The proposed system, if realized, will be the first in the country (to the best of our knowledge) and will directly benefit endoscopic research, education, and training. The anticipated broader impact includes: (1) Contribution to Medical Research, Education, and Practice. Experience learned from this project will be beneficial for development of similar technologies for other medical procedures. In addition, documentation of time spent in the various parts (i.e., of colon and other internal organs) can be used as evidence of quality. Such documentation has become increasingly important in the medical field. (2) Contributions to research-based training of graduate students: The proposed research will contribute to research-based advanced training of students in graduate and undergraduate programs in computer science and medical informatics at our institutions. The project will contribute to training of a new generation of computer scientists with a unique skill set supplement to traditional medical imaging. (3) Research opportunities for undergraduates and Outreach to pre-college students: The PI and co-PIs will present their research in undergraduate orientation classes to attract undergraduate students. Also, this research will enhance research opportunities for junior high and high school students participating in various Iowa State University programs (Summer Programs for Talented and Gifted, Program for Women in Science and Engineering) and national programs. (4) Broaden the participation of under-represented groups: The project will attract under-represented students to attend sponsored symposia, workshops, or summer research program such as Iowa Summer Research Experience.