Institute for High Dimensional Medical Imaging

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General Summary

The goal of our research is to develop new imaging systems that can be applied to clinical medicine now and in the future. High-dimensional, i.e., 3-dimensional (3D) and 4-dimensional (4D), imaging techniques have enabled noninvasive, realistic, uninhibited, and accurate observations of human spatial structures and their dynamics. The availability of real-time imaging with high-performance computers and medical virtual reality systems has expanded the possibilities for diagnosis, treatment, surgery, and medical education. The Institute for High Dimensional Medical Imaging has, therefore, established a system that facilitates cooperative research and development with international researchers and organizations.

Research Activities

Clinical application of high-definition, real-time medical imaging
We are performing research for the development of medical high-definition imaging technology and its clinical application using functional and morphological data obtained with X-ray computed tomography (CT) and magnetic resonance imaging.
We are developing a 4D motion system for analyzing human activities, such as the motions of the whole body. The system is driven by motion data obtained from anatomical and skeletal muscle models reconstructed from X-ray CT data sets.
This year we have started developing a 4D human body model that is able to deform several kinds of soft tissue, such as the skin and abdominal organs, skeletal muscle, and vascular system. We are also developing a display system that visualizes rapidly changing childhood growth with X-ray CT data.
This research is being performed by departments in our university in collaboration with Osaka University, Kyushu University, and Mayo Clinic (Rochester, MN, USA).

Development of endoscopic surgical robot system
We are developing an endoscopic surgical robot system that can be used to perform natural orifice transluminal endoscopic surgery. Robotic instruments enter the abdominal cavity orally and are used to perform surgery on the abdominal organs.
This year, we made improvements to increase the movable range of an overtube that has a flexure mechanism to maintain the robot's posture in the abdomen.
We are also continuing our research on a multiview camera system for endoscopic and robotic surgery.

Development of a surgical simulator for various surgical techniques
We are developing a simulator that can deal with various surgeries, such as laparotomy

and endoscopic surgery, using preoperative X-ray CT data of a patient.
Continuing from last year, we have made progress in integrating surgical navigation systems. We have developed an information display system that enables the surgeon to more easily understand navigation during surgery, which reflects in an operative plan based on a preoperative simulation.

Development of an image-guided surgery system
We are developing a system that can display blood vessels and tumors at the back of a surgical field in the form of 3D geometric models in multiple layers on a surgical field screen. Such improvements will make the navigation system more intuitive.
This year the Department of Surgery and the Department of Otorhinolaryngology again jointly performed navigation surgery in the high-tech navigation operating room of Daisan Hospital as a semiroutine procedure.
We developed methods to increase the accuracy of navigation during laparoscopic surgery in addition to a navigation function for trocar positioning and conducted clinical applications.

Application of high-definition medical image analysis to forensic medicine
By applying technology that we have developed for analyzing high-definition medical images, we are analyzing X-ray CT data sets of crime victims with the aim of developing new methods for future criminal investigations and for establishing new methods for creating court documents. As we did last year, this year we carried out 3D analyses of the position, depth, and angle of the attempted-murder victim's injuries using the victim's X-ray CT data set.
This research was performed in collaboration with our university's Department of Forensic Medicine, the Tokyo District Prosecutor's Office, and the Metropolitan Police Department.

Publications

Okamoto T, Onda S, Yasuda J, Yanaga K, Suzuki N, Hattori A. Navigation surgery using an augmented reality for pancreatectomy. *Dig Surg*. 2015; **32:** 117-23.

Onda S, Okamoto T, Kanehira M, Suzuki F, Ito R, Fujioka S, Suzuki N, Hattori A, Yanaga K. Identification of inferior pancreaticoduodenal artery during pancreaticoduodenectomy using augmented reality-based navigation system. *J Hepatobiliary Pancreat Sci*. 2014; **21:** 281-7.

Reviews and Books

Okamoto T, Onda S, Yanaga K, Suzuki N, Hattori A. Clinical application of navigation surgery using augmented reality in the abdominal field. *Surg Today*. 2015; **45:** 397-406. Epub 2014 Jun 6.