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 using 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 on 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 developed a gait-analysis system to simulate the changes to the knee adduction moment in varus-valgus deformity of the knee during gait and performed validations using preoperative and postoperative gait data from a patient with osteoarthritis of the knee.
This research is being performed by departments in our university in collaboration with Osaka 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 (NOTES). Robotic instruments enter the abdominal cavity orally and are used to perform surgery on the abdominal organs.
This year we developed an "over tube system" that can bend and maintain the posture of the robot in the abdominal cavity. 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.

This year we attempted to combine the surgical simulator and the navigation system. To share the surgical plan among surgery staff during the operation, the plan data made by preoperative surgical simulation transferred to the navigation system and displayed on navigation screen.

Development of an image-guided surgery system

We are developing a system that can display blood vessels and tumors at the back of the surgical field in the form of 3D geometric models in multiple layers on the 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. From this joint research, we developed a pointing device suited for various surgeries and a registration method with improved accuracy which was applied to clinical examination. We also started to develop a navigation system for laparoscopic surgery to deal with new surgical procedures.

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. In addition we developed methods to display in 3D, wounds of victims in incidents where there are only X-ray CT data in films or photographs from forensic autopsy.

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

Suzuki N, Hattori A. A concept for overlaid-type surgical navigation system with organ modification functions using non-contact type surface measurement. *Stud Health Technol Inform.* 2014; **196:** 409-15.

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Onda S, Okamoto T, Kanehira M, Fujioka S, Suzuki N, Hattori A, Yanaga K. Short rigid scope and stereo-scope designed specifically for open abdominal navigation surgery: clinical application for hepatobiliary and pancreatic surgery. *J Hepatobiliary Pancreat Sci.* 2013; **20:** 448-53.