Research Center for Medical Sciences
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 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, in collaboration with the Department of Plastic Surgery, we started research and development of a method to analyze the 4D changes of joints by focusing on the movement of the fingers in the upper limbs, measuring the magnetic resonance images of the fingers during movement.

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.

Continuing from last year, we developed a drive mechanism using a shape memory alloy for an overtube to control the posture of a robot in the abdominal cavity and presented the research results at an international conference.

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 developed a system that sets the resection plane on preoperative X-ray CT

data of the patient, performs intraoperative navigation with the set data, records the procedure of the operator, and analyzes and evaluates it after surgery. In addition, we worked for the third year on a 4D image display system in real space, with a Japan Society for the Promotion of Science Grant-In-Aid for Scientific Research (A). As we developed the structure of the experimental machine last year, this year we improved the structure and the function of an experimental machine to improve the display function. We also applied for a patent for the display method and device configuration of this system.

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 again jointly performed navigation surgery in the high-tech navigation operating room of Daisan Hospital as a semiroutine procedure.
This year, by using a system that we developed last year to navigate surgical procedures based on preoperatively planned excision surface data, we performed clinical trials during actual partial hepatectomy procedures and evaluated the system. In addition, to perform gynecological laparoscopy, we continue to develop a navigation system that does not use preoperative X-ray CT or magnetic resonance imaging data.

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. Regarding the X-ray CT data analysis of the cause of traffic accidents deaths of nationally protected animals, at an international symposium we presented the results obtained from accident data with analytical methods we developed.

Publications

Yasuda J, Okamoto T, Onda S, Fujioka S, Yanaga K, Suzuki N, Hattori A. Application of image-guided navigation system for laparoscopic hepatobiliary surgery. *Asian J Endosc Surg.* 2020 Jan; **13**(1): 39-45. doi: 10.1111/ases.12696. Epub 2019 Apr 3. PMID: 30945434.