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 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 (MRI).

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 evaluating the deformation of a skeletal muscle model using MRI in the development of a 4D human body model with deformable soft tissue (skin, abdominal organs, skeletal muscle, and vascular systems) during whole body motion. In the evaluation, we have developed a dynamic MRI measurement method that can measure in the same situation as when the body walks, with the same load applied. We are comparing the deformation of the real skeletal muscle of the lower limb during walking motions and the skeletal muscle model's deformation by measuring the deformation of the real skeletal muscle in 4D. In addition, by using various X-ray CT data we have previously measured, we are developing a system that visualizes the future growth of a child. 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.

Following our research from the previous year, this year we are refining the driving

mechanism of the over tube flexing mechanism to maintain the posture in the abdomen of the robot. In addition, we are also continuing our development of the multiple viewpoint camera system for endoscopic and robot surgeries.

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, to advance the integration of the simulator with the surgical navigation system we are developing, we started the development of a 4D imaging display system that enables the surgeon to instinctively grasp the patient's biological structure and its dynamics.

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.
This year, we developed a new display system. A surgeon can now view real-time navigation information from a tablet personal computer. We applied the system to clinical use.

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 performed 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

Suzuki N, Hattori A, Hashizume M (Kyushu Univ). Development of 4D human body model that enables deformation of skin, organ and blood vessel according to dynamic change. *Lecture Notes in Computer Science.* 2015; **9365:** 80-91.

Kimura T, Kubota M, Taguchi T, Suzuki N, Hattori A, Marumo K. Ability of a novel foot and ankle loading device to reproduce loading conditions in the standing position during computed tomography. *J Med Device.* 2015; **9:** 044506.