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., three-dimensional (3D) and four-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 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 emergency safety mechanism, improved the user interface, and carried out basic evaluations of the degree of accuracy and the delay in the robot's movement to bring the system closer to clinical application. In addition to pursuing our main research project, we started developing a camera for surgery navigation and various other surgical apparatuses.

Development of a simulator for the endoscopic surgical robot system
To perform surgery with the surgical robot system described above, the operator requires training because the operative method differs greatly from that of conventional surgery. Therefore, we are developing a simulator system for animal experiments that has the same functions as the actual surgical robot system.

This year, we improved the modeling and texture of the organ model in the surgical field so that operators can train in an environment as close as possible to the actual environment. In addition, we trained numerous people in the use of the system. The purpose of this training was to accumulate data about the time needed to complete tasks, the amount of blood loss, and the changes in robot-arm trajectory during training to verify the effectiveness of training with the 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 we performed 7 navigation operations in collaboration with the Department of Surgery and 5 in collaboration with the Department of Otorhinolaryngology in a high-tech navigation operating room in the Daisan Hospital. In joint research with the Department of Surgery, by adopting short-axis 3D laparoscope, we were able to acquire a stereoscopic view of the resection plane and target regions while navigating. In sinus surgery performed with the Department of Otorhinolaryngology, we were able to navigate through an oblique-viewing endoscope as well as through a forward-viewing 3D endoscope. In this way, we were able to provide navigation information for the entire operation.

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.

This year, we have analyzed the position, depth, and angle of a victim's wounds in 3D using the X-ray CT data set from a case of attempted murder.

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. System development for unrestrictive view and 4D shape acquisition in abdominal cavity operation using virtual space. *Stud Health Technol Inform*. 2012; **173:** 506-11.

Hattori A, Suzuki N, Ieiri S[1], Tomikawa M[1], Kenmotsu H[1], Hashizume M[1] ([1]Kyushu Univ). Training system for NOTES and SPS surgery robot that enables spatiotemporal retrospective analysis of the training process. *Stud Health Technol Inform*. 2012; **173:** 166-70.