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 focused on developing a multiview camera system and other surgical instruments for surgical navigation during endoscopic and robotic surgery. This research was derived from the "Endoscopic Surgery Support System Research Development Project," which we completed last year.

Development of Surgical Simulator for Various Surgical Techniques
Based on technology obtained from developing a surgical simulator for a surgical robot system last year, we are developing a simulator that can be used for various types of surgery, such as laparotomy and endoscopic surgeries.
This year, we created 3D models of surgical instruments needed for these surgeries and models of target organs and constructed an operational field environment in the virtual

reality environment.

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.
We are conducting joint research with clinical departments and developing systems that can be used for each type of surgery. This year we conducted numerous navigation surgeries: 5 cases with the Department of Surgery and 6 cases with the Department of Otorhinolaryngology in the operational ward in the high-tech navigation operating room of Daisan Hospital.
This year, we developed a method to display intraoperative registration needed for navigation to the surgeon more quickly and with greater accuracy. We also developed a method to display the names of organs in addition to the organ model on the navigation screen so that the surgeon is able to grasp the situation of the surgical field in a shorter period of time.
Moreover, we have started to develop a method to reflect organ deformation to the navigation system during surgery. The method we are developing measures the organ-surface configuration. The method reflects the change in the organ to the navigation by changing the organ model based on the measurement.

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, by introducing stereoscopic views into the analysis system we enabled court juries to grasp the 3D configuration of a victim's injuries more intuitively. We developed a system that displays the 3D model of a suspected weapon, such as a knife, in the same 3D space as the victim's X-ray CT data set so that juries are able to easily recognize that the shape of the weapon matches the victim's injury.
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

Suzuki N, Hattori A, Ieiri S[1], Tomikawa M[1], Kenmotsu H[1], Hashizume M[1] ([1]Kyushu Univ). Formulation of wire control mechanism for surgical robot to create virtual reality environment aimed at conducting surgery inside the body. *Stud Health Technol Inform.* 2013; **184:** 424-30.

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Okamoto T, Onda S, Matsumoto M, Gocho T, Futagawa Y, Fujioka S, Yanaga K, Suzuki N, Hattori A. Utility of augmented reality system in hepatobiliary surgery. *J Hepatobiliary Pancreat Sci.* 2013; **20:** 249-53.