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 observation 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 medical images by real-time imaging
We are performing research on the development of medical high-definition image technology and its clinical application using functional and morphological data of a body obtained with X-ray computed tomography (CT) and magnetic resonance imaging.
We are developing a 4D motion analysis system for human activity. An anatomic skeletal muscle model constructed from X-ray CT data sets is driven by motion data obtained with motion capture. This research is being performed by departments in our university in collaboration with Kyushu University, Osaka University, Tsurumi University, and the Mayo Clinic (Rochester, MN, USA).

Development of an 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. This year, we modified the system to allow 2 to 4 robot arms to be chosen. We were able to have the robot arms work together to perform surgery. By measuring the pulling force of the wires that drive the robot arms, we tested the functions that would display, to the operator, the softness of the objects that the robot arms grasp. This research is being performed with Kyushu University's department of surgery.

Development of a simulator for 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 deformation algorithm for grasping abdominal tissue. We modeled the characteristics of the abdominal wall as closely as possible to those of the actual wall and improved the soft tissue model so that reactions when the abdominal wall tissue is grasped and lifted with forceps would be the same as those of the actual wall. This research was performed in collaboration with Kyushu University's department of surgery.

Development of a surgical navigation system
We are developing a surgical navigation system that can perform data fusion for 3D images of the interior structure of veins, nerves, or tumors that cannot be seen with the naked eye when surgery is performed under the skin or within organs. This year, continuing a project with our university's department of otorhinolaryngology started last year, we performed microscopic surgery once and stereoendoscopic surgery 3 times in the high-tech navigation operating room of Daisan Hospital.
Moreover, in the "intelligent surgical instruments project," performed in collaboration with Kyushu University, we tested a real-time information integration display system for surgery of the gastrointestinal tract that detects the 3D position and the direction of the tip of an endoscopic surgical system and used the system to perform data fusion of endoscopic images with a patient model.

Application of the 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, at the request of the Tokyo District Prosecutor's Office, 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. The results were used as evidence in court for the first time.
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

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