Institute for High Dimensional Medical Imaging

Naoki Suzuki, *Professor*　　　　　　　　　　Asaki Hattori, *Associate Professor*

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 lower limbs and lower jaw. 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 Kyushu University, Osaka University, Tsurumi University, and the 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.
This year, in addition to having the robot arm move freely (up and down, right and left, the opening and closing of the forceps), we added the function of having the robot arm rotate and move forward and backward. As a result, we constructed a prototype that can perform even more complicated surgery. By measuring the pulling force of the wires that drive the robot arms, we improved 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 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 constructed a prototype cockpit similar to that of the actual system and created an environment where the training could be performed with the same interface as the actual system. We could simulate surgical interruption of the inner membrane on a stomach lining model by coordinating the robot arm and a needle knife.

This research is being performed in collaboration with Kyushu University's department of surgery.

Development of an image-guided surgery system

We are developing a surgical navigation system that can perform data fusion for 3D images of the interior structures 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, in a collaborative study with our university's department of otorhinolaryngology, we performed stereoendoscopic sinus surgery 3 times and with our university's department of surgery performed hepatobiliary pancreatic surgery with laparotomy once in the high-tech navigation operating room of the Daisan Hospital.

Moreover, in the "intelligent surgical instruments project" being performed in collaboration with Kyushu University, we developed a data fusion display system that displays both the operative field and the navigational image, the patient's information during the operation, and a color-changing indicator to show the softness of objects the robot arm has grasped.

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.

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, Tanoue K[1], Ieiri S[1], Konishi K[1], Kenmotsu H[1], Hashizume M[1] ([1]Kyushu Univ). Development of endoscopic robot system with augmented reality functions for NOTES that enables activation of four robotic forcep. *Proceedings of AMI-ARCS* 2009: 12–8.

Suzuki N, Hattori A, Tanoue K[1], Ieiri S[1], Konishi K[1], Kenmotsu H[1], Hashizume M[1] ([1]Kyushu Univ). New endoscopic robot system for NOTES that enables activation of four robotic forceps for free

surgical maneuvers. *Int J Comput Assist Radiol Surg* 2009; **4 Suppl 1:** 243–4.

Hattori A, Suzuki N, Ieiri S[1], Konishi K[1], Maeda T[1], Fujino Y[2], Ueda Y[3], Navicharen P[4], Tanoue K[1], Hashizume M[1] ([1]Kyushu Univ, [2]NTT, [3]NTT Communications Corp, [4]Chulalongkorn Univ). Tele-controlled endoscopic surgical robot system experiment between Japan and Thailand. *Int J Comput Assist Radiol Surg* 2009; **4 Suppl 1:** 242–3.