Origami Folding Robot - A Case Study of Dextrous Hand Design and Skilled Motion Teaching

Abstract: Dexterous manipulation by a robotic hand is a difficult problem involving (1) how to design a robot that has a capability to achieve a target task and (2) how to control the designed robot to actually conduct the task. In this talk, I will show our approaches to these problems, taking “Origami folding” as a target task.

In the first part of my talk, I will introduce an origami-folding robot that can fold a “Tadpole”, a simple origami form but needs “squash folding”. The robot was designed based on our design philosophy, i.e., not blindly mimicking the appearance of the human hand but understanding the essence of the target task and designing a mechanism as simple as possible. Designing nice robot hardware is not enough to perform skilled tasks. We have to implement manipulation skill to the robot in some way so that the robot can cope with the variation of environmental properties. However, manipulation skill, which is a sort of implicit knowledge, is very difficult to be transferred even among humans. Skill transfer from human to robot is even more difficult because humans and robots have dissimilar bodies.

In the second part, I will introduce a novel method to synthesize a desired trajectory and sensory feedback control laws for robots based on the statistical characteristics of direct teaching data by a human. The proposed method was applied to the origami-folding robot and experimental results showed that the success rate and the folding quality of `Valley-fold` were improved.

Finally, I will discuss a problem such as “what is the manipulation skill for robots?”.

Biography: Yasuyoshi Yokokohji was born in Osaka, Japan, on August 4, 1961. He received B.S. and M.S. degrees in precision engineering in 1984 and 1986, respectively, and Ph.D. degrees in mechanical engineering in 1991 all from Kyoto University, Kyoto, Japan. From 1988 to 1989, he was a Research Associate in the Automation Research Laboratory, Kyoto University. From 1989 to 1992, he was a Research Associate in the Division of Applied Systems Science, Faculty of Engineering, Kyoto University. From 1994 to 1996, he was a visiting research scholar at the Robotics Institute, Carnegie Mellon University, Pittsburgh, PA. He is currently an Associate Professor in the Department of Mechanical Engineering, Graduate School of Engineering, Kyoto University. His current research interests are robotics and virtual reality including teleoperation systems, vision-based tracking, and haptic interfaces. Dr. Yokokohji is a member of the Institute of Systems, Control and Information Engineers (Japan), the Robotics Society of Japan, the Society of Instruments and Control Engineers (Japan), the Japan Society of Mechanical Engineers, the Society of Biomechanisms of Japan, the Virtual Reality Society of Japan, IEEE, and ACM.