PhD thesis offer (funded)

Title: Construction and Retrieval of Multi-contact Motion Library for Humanoid Robot

Directors: F. Kanehiro (AIST), I. Kumagai (AIST)

Period: start as soon as possible (duration: 36 months)

Keywords: Robotics, Motion planning, Humanoid robot, Multi-contact, Motion library

University (degree): University of Montpellier

Location: CNRS-AIST Joint Robotics Laboratory (JRL), Tsukuba, Japan.

Description:

In CNRS-AIST JRL, we develop a humanoid robot that can take over dangerous or big burden tasks on human workers like large-scale manufacturing [1]. In these scenarios, the robot needs to perform tasks while contacting its arms and legs with environmental structures, which we call multi-contact motion. However, it is difficult to plan multi-contact motion online because the robot needs to satisfy complex kinematics and dynamics constraints, which consumes a large amount of computational time [2]. One promising solution to this problem is preserving feasible motion in a library and adapting it to new environments [3]. However, due to the complex kinematics and dynamics constraints in multi-contact motion, it is difficult to adapt preserved motion to different environments and tasks. In the field of computer graphics, some methods adapt motion captured from a human actor to a character in a complex environment like video games [4]. This approach successfully provided an animation of a character according to the commands from users online, but it prioritized the user experience over the physical consistency, which cannot guarantee the feasibility of the resulting motion for a humanoid robot in the real world. We offer research about the methodology of construction and retrieval of motion library to achieve on-site multi-contact motion planning for a humanoid robot. We want to clarify the structure of the motion library, which can preserve the feasible whole-body motion of a humanoid robot. We also want to develop the online adaptation method to modify preserved motion to satisfy kinematics and dynamics constraints in an unknown environment. We can provide life-sized humanoid robots [5, 6] and their software for evaluation experiments in large-scale manufacturing scenarios. We expect that the results will be published in journals and conferences (T-RO, RA-L, ICRA, IROS, Humanoids, etc.).

Required skills: Basic knowledge of robotics, Software development by C++ and Python with ROS

Applications: send your CV and cover letter to f-kanehiro@aist.go.jp and iori-kumagai@aist.go.jp.

References:

[1] A. Kheddar et al. “Humanoid Robots in Aircraft Manufacturing: The Airbus Use Cases”, IEEE Robotics and Automation Magazine, 2019, pp. 2-17

[2] S. Brossette et al. “Multicontact Postures Computation on Manifolds” IEEE Transactions on Robotics, 2018, pp. 1252-1265, vol. 34, issue. 5

[3] Y. Lin et al. “Using previous experience for humanoid navigation planning”, IEEE-RAS International Conference on Humanoid Robots, 2016, pp. 794-801

[4] D. Holden et al. “Learned Motion Matching”, ACM Transactions on Graphics, 2020, pp. 1-13, vol. 39, issue 4

[5] K. Kaneko et al. “Humanoid Robot HRP-2Kai - Improvement of HRP-2 towards Disaster Response Tasks

–“, IEEE-RAS International Conference on Humanoid Robots, 2015, pp. 132-139

[6] K. Kaneko et al. “Humanoid Robot HRP-5P: An Electrically Actuated Humanoid Robot With High Power and Wide Range Joints”, IEEE Robotics and Automation Letters, 2019, pp. 1431-1438, vol. 4, issue 2