Robot Learning by Demonstration for Heterogeneous Bimanual Collaboration Tasks

Robot learning by demonstrations (RLD), also known as imitation learning, plays an important role in human-robot interactions (HRI) because it creates a user friendly environment for non-expert end-users to teach a robot new skills. Recent advances in sophisticated humanoid and service robots provide an opportunity for these robots to manipulate everyday tools and objects in an unstructured environment.

On a daily basis, human partners extensively with others on many goal-directed tasks. This allows the task performance to be much faster than individual work on the same task by leveraging the synergies among partners. However, many of these tasks are dull, dangerous and dirty, and require the humans to push to their physical limits. To offload some of these tasks to a team of robots or a partnership between robots and human, the robots have to possess the capability to learn not only to perform a complete individual task but also to perform a task jointly with a human/other agent and at the same time do not demand the partner to change its original behaviours. This can be viewed as a heterogeneous bimanual collaboration task.

Traditional RLD paradigms focus purely on the generalisation aspects of learning which makes adaptation of the learning task harder to be useful in a new scenario especially when a human is in the loop. Thus, this novel research topic tries to investigate a new learning paradigm to address the issue of learning to perform a heterogeneous bimanual collaboration task. It will include multimodal sensory inputs from a demonstration task to be used for extraction of relevant information for the robot to learn the complete task. This can be viewed as a hierarchical model of action representation with a cascade of primitive models intermixing with each other (Demiris Y, Khadhouri B, RAS, 2006). When a robot is requested to participate in the task, it will assign the complementary role to its partner on-the-fly and actively monitor and adapt the task execution. This is finding a subtask in a learning template of action model (Wu Y, Su Y, Demiris Y, RAS, 2014).

The construction of this novel paradigm allows robots with difference embodiments to interact with other agents to complete a task including the use of tools that is otherwise hard to be performed by a single agent. This is particularly useful in factory floors where handling of dangerous goods is a daily routine or in laboratories where accidents happen frequently on handling of hazardous materials. Robot in these applications can help to reduce to risk of its partner’s exposure to unnecessary dangers.


Contact Information:

Dr Wu Yan, Scientist I, I2R, A*STAR (wuy@i2r.a-star.edu.sg)

Assoc. Prof Yiannis Demiris, Reader in Human-Centred Robotics, Imperial College London (y.demiris@imperial.ac.uk)