2018-00548 - Machine learning for optimization of human-robot movements with energetic/ergonomics criteria

Level of qualifications required: Graduate degree or equivalent
Function: Internship Research

Context
The goal of this internship is to combine state-of-the-art machine learning techniques to whole-body controllers of simulated humanoid robots and human-like characters, to optimize the movement with respect to ergonomics and energetic criteria.

The internship is realized in the context of the European Project AnDy [1], focused on human-robot collaboration. One of our objectives is to provide the robot with the capabilities to optimize its actions so as to take into account the ergonomics comfort.

For doing so, a human operator will be equipped with inertial and force sensors (Xsens MVN Link suit and force plates) to record some demonstrations of pick & place whole-body motions. The motions will be replayed in a simulation and control framework, using a whole-body QP controller, where the human is approximated by a rigid body model using a URDF description, as we did in [2]. The whole-body controller will be parameterized, as well as the trajectories for the pick & place task, computed from the human demonstrations.

The objective is to apply state-of-the-art machine learning algorithms to optimize some parameters of the controller and/or of the motion trajectories, with respect to energetic and ergonomics criteria.

A possible solution will be to take on a reinforcement learning approach, where a measure of performance of the whole movement is computed and used to optimize the parameters, as we did in [3] for humanoid motions. Particular attention will be devoted to try data-efficient algorithms that enable a fast optimization in few trials, developed in the context of the Resibots project [4].

The student will develop software modules interfacing our machine library Limbo [5] with our control framework based on OpenSOT [6].

The next step will be to test his/her optimization module online with the iCub robot, helping a real human in the pick & place task by optimizing the location of the object to be picked from the robot (handover).

Active collaboration with the researchers in the AnDy and the Resibots projects will be required. Demonstrations with the iCub robot handling an object to a human wearing the XSens suit are expected at the end of the internship.

References:
[1] ANDY project: http://andy-project.eu/

Assignment
The student will develop the software to interconnect the existing libraries, in particular OpenSOT.
and Limbo. There are available software modules for interfacing the sensors on YARP/ROS and also for controlling the robot. The candidate can rely on existing modules for whole-body control, with kinematics/dynamics controllers.

The candidate is expected to test and validate the software in one collaborative scenario with the human and the robot (of course, with the help of the other engineers).

The student will closely work with the AnDy team, with both researchers and engineers.

Main activities

- Develop the software modules for applying machine learning algorithms to the human simulation
- Execute parallel optimization runs on a cluster
- Write documentation
- Test and validate the optimized trajectories with a real human interacting with a robot in a collaborative scenario.

Skills

Technical skills and level required:

- Strong programming skills
- Good knowledge of C++ and programming tools (CMake, git)
- Working knowledge of Linux/Ubuntu

Languages:

- Very good technical English required, as documentation will be in English and the candidate will interact with other international engineers/researchers
- French is a plus, but not mandatory

Relational skills:

- Excellent communication and collaboration skills, as the candidate will have to work in close collaboration with engineers, postdocs, phds and researchers

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport

Remuneration

500 euros/month