2018-00696 - PhD in Intelligent cooperation between human and robot

**Level of qualifications required:** Master’s or equivalent  
**Fonction:** PhD Position

**Context**

The PhD candidate will join the team working in the European Project AnDy (http://andy-project.eu/), a H2020 funded project with several international partners in Germany (DLR), Slovenia (JSI) and Italy (IIT).

One of the objectives of the AnDy project is to realize collaborative scenarios between the humanoid robot iCub and a human partner, equipped with several wearable sensors. Collaboration is intended as anticipatory physical interaction that assists the human partner in realizing a task while optimizing some criteria (equilibrium, effort, ergonomics). For example, we need to realize a collaborative assembly or pick & place task, where the iCub and the human partner pick an object together, transport it (eventually) to a desired location, and then place it, to make some assembly.

In this context, we would like to develop online control & learning algorithms to control the robot's motion when interacting with a human partner, taking into account the numerous constraints of both partners (e.g., balance, dynamics, efforts) including the ergonomic performance of the human during the tasks. The ability to anticipate the human will be possible by algorithms for predicting the future human movement and goal, already developed in the team. To make the collaboration more efficient, the robot will have to adapt to the human "role" (leader/follower) and therefore estimate the human control and provide appropriate optimized controls.

The main challenge for this PhD thesis is to produce robot control algorithms that are able to adapt in very few trials with the human, optimizing the ergonomics and collaboration performance metrics while satisfying the numerous constraints of the problem. The online learning / optimization in few trials is crucial to realize the algorithms with the real robot. The thesis is therefore a mix between robot control (multi-task and multi-constraint whole-body control) and machine learning (reinforcement learning, data-efficient learning), two themes that are currently well developed in the team. The candidate will have to evaluate his/her algorithms with the iCub humanoid robot in two collaborative settings (pick & place and co-assembly), his/her demonstrations will be presented at the review meetings of the project AnDy.

The PhD candidate will be immersed in a dynamic environment, with plenty of interactions with researchers in data-efficient learning, robot learning, HRI, robot tele-operation and control.

**Lab equipment:** the iCub robot, two Xsens MVN Link suits, sensorized gloves and shoes. Force plates and external motion capture Qualysis/Optitrack are also available.

**About the team:** the PhD candidate will work in cooperation with the other engineers, researchers and PhD students of the team LARSEN, and more specifically with the AnDy team lead by Serena Ivaldi (https://members.loria.fr/SIvaldi/) and the Resibots team lead by Jean-Baptiste Mouret (https://members.loria.fr/JBMouret/). The LARSEN team consists of 7 full-time researchers and several postdocs, phd and engineers, french and international. The team LARSEN is doing research in both robotics & AI, particularly in robot learning, human-robot interaction and probabilistic models. More in: https://team.inria.fr/larsen/

**About Inria:** established in 1967, Inria is the only public research body fully dedicated to computational sciences. The team LARSEN's laboratory is located in the research center of Inria Nancy-Grand Est in the heart of a major cross-border region that facilitates industrial and academic partnerships between France and Germany. Nancy is a student city, conveniently located at 1h20 from Paris and 1h from Luxembourg.

**Assignment**

**Keywords:** Robot control, reinforcement learning, human-robot interaction

The PhD will be in charge of designing and developing the algorithms for online optimization of the robot movement. The candidate can rely on existing modules for whole-body control, with kinematics/dynamics controllers. The PhD candidate is expected to test and validate the software on collaborative R&D projects is a plus.

**General Information**

- **Theme/Domain:** Robotics and Smart environments  
- **Town/city:** Villers-lès-Nancy  
- **Inria Center:** CRI Nancy - Grand Est  
- **Starting date:** 2018-05-02  
- **Duration of contract:** 3 years  
- **Deadline to apply:** 2018-05-15

**Contacts**

- **Inria Team:** LARSEN  
- **Recruiter:** Ivaldi Serena / serena.ivaldi@inria.fr

**The keys to success**

- Master or equivalent in robotics, machine learning or informatics  
- Excellent cooperation and communication skills  
- Experience with software development, excellent programming skills and C++ knowledge  
- Strong knowledge and/or expertise in robotics  
- Autonomy, proactivity and passion for  
- Prior experience with real robots and collaborative R&D projects is a plus

**About Inria**

Inria, the French National Institute for computer science and applied mathematics, promotes "scientific excellence for technology transfer and society". Graduates from the world's top universities, Inria's 2,700 employees rise to the challenges of digital sciences. With its open, agile model, Inria is able to explore original approaches with its partners in industry and academia and provide an efficient response to the multidisciplinary and application challenges of the digital transformation. Inria is the source of many innovations that add value and create jobs.

**Conditions for application**

**Defence Security:**

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy:**

As part of its diversity policy, all Inria positions
the real robot iCub in collaborative scenarios with human partners equipped with the XSens MVN suit. The PhD will produce high-quality open-source software with documentation.

The recruited PhD will closely work with the AnDy team, with both researchers and engineers working already with this experimental setup.

**Main activities**

- Develop new robot control & learning algorithms
- Develop the software modules for learning and controlling the robot
- Execute parallel optimizations on a cluster
- Ensure quality code with documentation
- Validate the developments on the iCub robot
- Collaborate with the other team members, in particularly engineers
- Publications in top conferences and journals (e.g., ICRA, Humanoids, HRI, TRO)

**Skills**

Technical skills and level required:

- Strong programming skills
- Very 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
- Social security
- Paid leave
- French courses

**Remuneration**


Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).