Offer #2023-06327

PhD Position F/M Inexact optimization for the control of robots

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Assignment

In the current time of major, global ecological crisis, robots could help us satisfy more efficiently our most basic needs (food, health, clothing, housing, transport), but to do so, they should reduce their own ecological footprint, considering the energy and overall resources necessary to manufacture and operate them. One overlooked aspect in this regard is the design and implementation of control laws, which can lead to intensive computations and impact the whole hardware design of robots.

The control of complex robots is commonly computed by numerically solving optimization problems [1,2]. These problems are often small enough (from tens to a few thousand variables) that they can be solved exactly, or with the highest numerical precision available. It would be beneficial, however, to study what precision is really needed at the different computation steps: formulation of the problem, accuracy of the solution or inner computations of the optimization. This could help perform cheaper computations, allowing faster resolution and better energy efficiency.

The goal of this PhD is to develop numerical formulations and dedicated solvers taking advantage of a reduced need for precision, to decrease the computations footprint. In particular, classical decisions made within optimization algorithms will be revisited with the inexact aspect in mind, to apply to cases where the input and output precisions are orders of magnitude lower than usually considered in optimization theory. The developments will be applied to the control of different robots in various scenarios (humanoid, quadruped and industrial manipulator robots as well as self-driving vehicles).

Machine learning approaches have been providing very interesting solutions to various robotics problems recently, but these solutions are approximate by construction. This connection between optimization and machine learning through the role of approximate solutions appears to be a key question to investigate more advanced control of robots.

References

[1] J. Carpentier, P.-B. Wieber, “Recent progress in legged robots locomotion control”, Current Robotics Reports, vol. 2(3), 2021
[2] P. Wensing, M. Posa, Y. Hu, A. Escande, N. Mansard, A. Del Prete “Optimization-Based Control for Dynamic Legged Robots”, submitted to IEEE Transactions on Robotics, 2022
[3] N.A. Villa, J. Englsberger, P.-B. Wieber "Sensitivity of legged balance control to uncertainties and sampling period", IEEE Robotics and Automation Letters, 2019
[4] A. Bambade, S. El-Kazdadi, A. Taylor, and J. Carpentier "PROX-QP: Yet another Quadratic Programming Solver for Robotics and beyond", Robotics: Science and Systems 2022

Skills

Technical skills and level required :

- A strong background in robotics and numerical optimization. Machine learning is a plus.
- A good knowledge of C++ and Python

Languages :

- Fluent communication in French or English
- Ability to read and write technical documents in English

Relational skills :

- Ability to work in a team

Benefits package

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

General Information

- **Theme/Domain :** Robotics and Smart environments
- **Town/city :** Paris
- **Inria Center :** Centre Inria de Paris
- **Starting date :** 2023-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2023-06-30

Contacts

- **Inria Team :** WILLOW
- **PhD Supervisor :**
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Instruction to apply

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