ABSTRACT

This internship aims to develop a generic toolbox for legged robots dynamic identification and geometrical calibration. Existing works will first be validated on simple prototypes build at LAAS-CNRS and then optimization approaches will be developed to normalize and scale up the dynamic identification and geometrical calibration process to large size humanoid robots.

PROJECT

Legged robots are the target of intensive research and their field of applications is everyday broadening. Their challenging conception is about finding a good trade-off between accuracy, power, and segment size reduction for mobility. To reduce design cost and time, affordable manufacturing methods are often used. This makes these robots more prone to undesired joint backlash and flexibilities and makes the knowledge of their CAD data (geometry, mass, center of mass and inertia of each of the robot’s segment) somehow inaccurate. Inaccuracies might also come from unmodelled phenomena at the actuation chain level or during the assembling process. However, the knowledge of these parameters is of crucial importance for simulating these highly nonlinear redundant systems and to develop model-based controllers. Indeed, the robustness and accuracy of a controller depend highly on the ability to predict and estimate in real-time the dynamic behaviour of the robot. The manual, accurate and individual measurement of hundreds of these parameters appears cumbersome. Thus, the legged robots community is looking for new solutions for a quick and accurate geometrical calibration and dynamic identification of its robots while they are assembled. Recent works at LAAS-CNRS showed that geometrical parameters of a humanoid robot can be efficiently estimated using a mocap system. Unlike classical laser tracker, it can measure, for a given posture, numerous markers 3D position reducing significantly the time required for the calibration process. The last decade has also seen the development of dynamics identification methods for floating base systems [2]. Since in most of the humanoid robots joint torque measurement is not available external generalized forces and moments can be used to identify inertial parameters. The humanoid robot TALOS from LAAS-CNRS possesses the ability to measure the actuator current and the joint torque. Thus, the drive chain dynamics could be identified for the first time on a humanoid robot to improve the whole-body torque control of such robots. Despite recent breakthrough in the field, whatever the approach, inverse kinematics and inverse dynamics computation suffers from modelling and differentiation inaccuracies. Thus, we believe that, to obtain a consistent robot’s state estimate, the geometric calibration and the dynamics identification should be performed at the same time [3] and that elastic parameters such as joint and segment flexibilities should be accounted for [4]. To normalize the calibration/identification process and to minimize the required time, it is preferable to use motions that were specifically designed to excite the parameters to be identified. Several studies from the literature on serial manipulators have proposed to generate...
optimal exciting motions using optimization approaches. However, in legged robots solving optimization problem is difficult due to the dimension of the problem as the exciting motions must guarantee dynamic balance and mechanical limitations while avoiding auto-collisions. Furthermore, because of legged robots’ conception, the level of noise/inaccuracy and deformation in each actuator/sensor/part might be drastically different. These are specific to each robot and can hardly be simulated. Thus, it will be interesting to have a robot-specific online generation of optimal exciting trajectories. The general idea would be to generate iteratively these trajectories by giving more weight in the optimisation to some parameters depending on their influence and on the results of the ongoing identification process [5]. To do so the student will be able to use state-of-the art adaptive filter [3] or hierarchical optimisation solver developed at LAAS-CNRS [6]. The modelling work will be done using the LAAS-CNRS C++/Python modelling library called Pinocchio (https://github.com/stack-of-tasks/pinocchio) [7]. The student will enrich this library by participating to the development of a general opensource toolbox to perform geometrical calibration and dynamic identification of legged robots.

REFERENCES


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