Robotics and Embedded Systems

Master/Bachelor Thesis

Forward-Backward Adaptive Control for Quadrupedal Robots with Unknown Loads

Background

Quadrupedal robots frequently need to carry or drag payloads during practical applications. Current Model Predictive Control (MPC) approaches primarily rely on simplified single rigid body models and employ feedforward compensation to handle model errors. Recent work using ARMAV has demonstrated effectiveness in dealing with model uncertainties [1]. However, when the payload is connected through an elastic rope, the coupling between the rope's elasticity and robot motion introduces significant periodic disturbances in the robot's state variables. In such scenarios, the ARMAV model shows limitations in capturing periodic characteristics. Additionally, changes in payload require better identification methods for system mass and inertia parameters. For forward pass compensation, we propose using ARIMA models to predict and compensate for periodic disturbances. In the backward pass, drawing inspiration from data-driven methods in visual servoing control, we utilize historical data to learn and adapt system parameters. The project will be implemented using the OCS2 optimization control framework on the Unitree Go2 quadrupedal robot platform [2], which provides comprehensive hardware and software support for algorithm validation.

Your Tasks

In this thesis, you will develop a forward-backward adaptive control method to address the elastic payload problem in quadrupedal robots:

1. You will learn knowledge about model predictive control and numerical optimization.
2. You will work on the basis of our current algorithm and further improve the algorithm or develop a novel algorithm.

Requirement

- High self-motivation and passion on research.
- Six month working time.
- Existing knowledge about MPC and C++ programming.

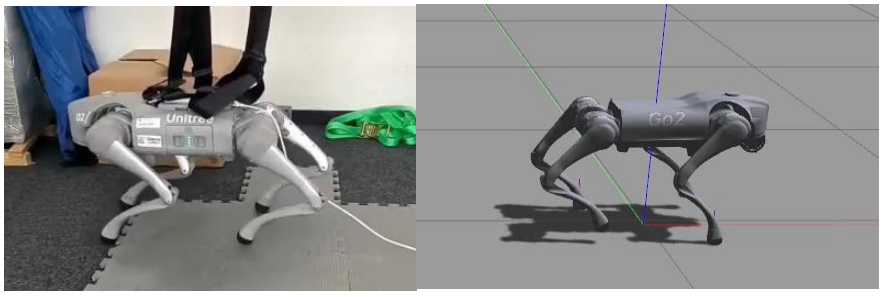

Figure 1 Simulation and experiment of quadruped control with OCS2.

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[1] *Adaptive Model Predictive Control with Data-driven Error Model for Quadrupedal Locomotion.*

[2] *Overview - OCS2 1.0.0 documentation*