Quadruped walking/running simulation

Short description

At the ASL, we are currently developing a series of quadruped robots that are not only able to move statically in rough terrain but should also perform highly dynamic maneuvers, such as trotting or galloping. So far, we have conducted simulation studies towards finding efficient gaits in planar models and successfully tested promising control approaches on a single leg test bench. We’re currently in the stage of finalizing the first 3D prototype, and now seek to develop a numerical simulation of this robot.

In this thesis, you will create and control a full 3D model of our quadruped using MATLAB/Simulink and the SimMechanics toolbox. While creating the multi-body simulation will be rather straightforward (the major issue in this process will be the simulation of the intermitted ground contacts, for which you need to develop a number of (nonlinear) spring-damper elements), controlling this system with 12 actuated (leg joints) and 6 unactuated (floating base) DoFs will pose a major challenge.

In contrast to kinematic control (following preplanned trajectories for each joint angle), as it is implemented in the static walk of our small quadruped ‘ALoF’, the new system grants the possibility of precise joint torque control. This allows the implementation of virtual model control strategies. We can, for example, create a spring-like behavior between the main body CoG and the ground. This technique, enables us to generate highly efficient dynamic maneuvers, such as bounding or trotting.

The goal of this work is the creation and stabilization of such periodic motions. Useful skills include a good grasp of linear algebra, multi-body dynamics, and control theory. It’s imperative that you’re absolutely familiar with MATLAB/Simulink.

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Partner -
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Student(en) / student(s) -
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Key words
Simulation, Controller Design, MATLAB/Simulink, Legged Locomotion

Context

This work is part of a larger research project towards the combination of passive dynamic running and mobility in unstructured terrain. Inspired by principles used in nature, a quadruped including well designed mechanical compliance is being developed.

Work packages
- Simulation with MATLAB/Simulink and the SimMechanics toolbox
- Inclusion of ‘soft’ intermitted ground contacts
- Implementation of standard joint position controllers for static walking in simulation
- Design of virtual model control to create dynamic maneuver in 3D and stabilization of these motion with simple high level control mechanisms