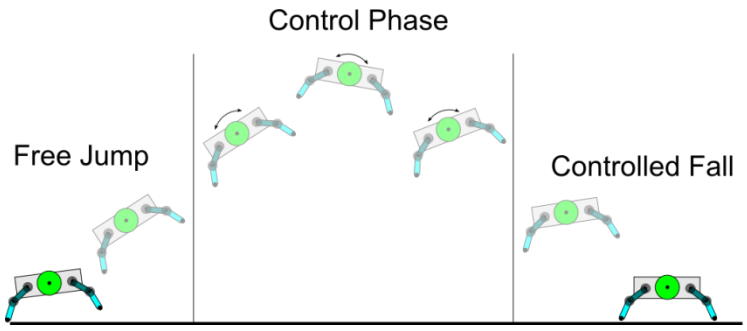
BDRL-UP-10: Pitch Control of a Jumping Quadruped Robot

Problem Statement

This problem involves the pitch control of a jumping quadruped while it is in the flight phase. The aim is to make the robot fall on its four legs by controlling a mounted wheel on the robot, after the robot jumps freely into the air.

Project Description

In this project, you are asked to come up with a control method for a mounted wheel on the robot to control the pitch angle of the quadruped in its flight phase. The overall phases of the motion are shown in the following figure.



In the figure above, 3 distinct phases of the motion is shown. In the first phase, the robot is thrown up in the air without any restriction. The core of the project lies in the second part, the control phase. In this phase, the aim is to rotate the on-board actuated wheel in order to adjust the torques transmitted to the robot body in the free air. Similar to trying to turn around yourself while sitting on a rotating chair with your feet off the ground, trying to rotate the wheel to control the robot's pitch angle will be a hard problem to solve. You will try to come up with a sequence of rotation controls which will eventually make the robot fall on its four legs, depicted in the third phase; controlled fall.

Expected Project Outcomes

The project will be complete if you could create a feedback loop for the wheel control which will always make the robot fall on its 4 legs, independent of the initial jumping configuration.

Optional Extras

In order to eliminate rolling, robot will be attached to the end of BDRL's planarizing boom, which enables motion on 2D space. Robot's legs should be passive and strong enough to survive the impact forces during landing. You may use inertial sensors on the robot or use BDRL's planarizing boom's position sensors on the attachment joint to detect pitch angle of the robot. A feedback loop should be constructed to control the actuated wheel on the robot. Although the focus of the project is to make the robot land safely, you may want to build a jumping mechanism instead of throwing the robot to the air in the free jump phase.

Desired Skills / Background

Team could be up to 3 participants, preferably consisting of ME and EE students. CE students are also encouraged to join. Desires skills would be;

- Knowledge about dynamics and kinematics,
- Feedback and motor control

For more information: Utku Çulha, culha@cs.bilkent.edu.tr