[7.1.2021]

[C-CROC: Continuous and Convex Resolution of Centroidal Dynamic Trajectories for Legged Robots in Multi-contact Scenarios]

Summary

This paper/lecture mainly talks about. The key take-aways are the contents are not in the exam horizon.

- Multi-contact problem: in contrast to gaited motions which are normally referring to the periodical motion, and often on a flat terrain, multi-contact deals with more general contact problem where gait is not necessarily periodical, and the terrain is more convex → combinatorial problem where contact has to be chosen.
- Considering two states separated by at most one contact creation and one contact break, this method is able to determine if there exists a valid transition that kinematically and dynamically feasible.

Thoughts

- What does the paper deepGait borrow from this paper? Simply the state phase and transition feasibility notation, or does the nonlinear solver used in this paper is also used in the paper deepGait?
    - Deepgait use the idea of transition feasibility, because in deepGait, the state is to be learned/predicted and tracked. In a RL framework, there requires a transition between states.
    - The transition feasibility here plays the role of a special transition dynamics: termination transition.

- Nonlinear solver is not used in both articles. After parametrizing the CoM trajectory, the feasibility is actually a LP problem, and this LP is also leveraged into deepGait → the form differs as that depends on the actual robot.
    - An additional cost can also be introduced to minimize → QP problem, still easy and efficient to solve.

- What is Bezier curve representation and what is the advantage?
    - A mathematical formulation: trajectory of the CoM can be formulated as:

$$\mathbf{c}(t) = \sum_{i=0}^{n} B_i^n(t/T)\mathbf{P}_i$$

        - Restricting n=6, given two states, we need to have six points to uniquely define the trajectory, setting n=6 allows us a freedom degree
        - The non-convexity of the problem disappears if we parameterize c(t) like this way → the problem of determining the transition feasibility becomes the problem of <u>checking the feasibility of a convex problem</u>.
        - Because restricting n = 6, the solution space is shrank → that's why it is conservative. → about 60% of solution can be found in complex terrains.

- What is the resolution of the problem? And how introducing the reformulation in this paper helps on this issue?
    - Faster → conservative formulation, so get a subset of feasible trajectories.

- What is N-step capturability problem?
    - Given the current state of the robot, determine if it will be able to come to a stop without falling in at most N steps.