Controlling the spring-mass running robots during the stance phase

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1 Motivation

Our motivation comes from the robust and efficient running of the Spring-Loaded Inverted Pendulum (SLIP) model [1-2]. If a mechanical system is controlled to have a dynamical behavior like SLIP model, it should have the same stability and robustness.

2 State of the Art

The behavior of the SLIP model has been widely investigated [1-2], spurring researchers to build legged robots based upon this model [3-4] such as ATRIAS (Figure 1). However, the mass of the actual robot cannot be sufficiently lumped to approximate the model. More importantly, accelerating the inherent motor inertias make the actual mechanical system deviate further from the ideal mathematical SLIP model.

3 Own Approach

We control the magnitude and the direction of the ground reaction force (GRF) to be the same as the equivalent SLIP model, such that the GRF passes through the CoM of the robot.

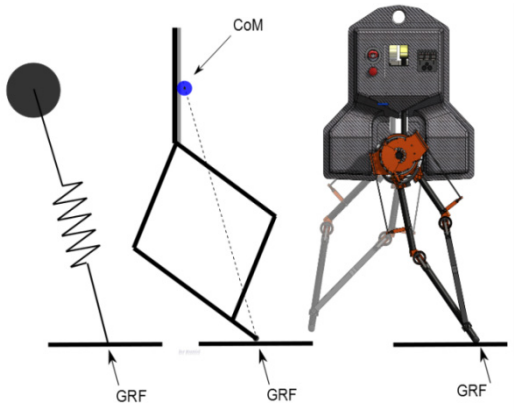

Figure 1: Ground reaction force (GRF) is controlled to pass through the CoM.

For this purpose, we control the toe force to follow the horizontal and vertical component of the leg force profile of the corresponding SLIP model. This controller treats the ideal SLIP model leg-force profiles as the target profiles to be followed.

4 Current Results

The resulting CoM trajectory of the full model of the robot, derived from the Lagrangian formulation of the spring-legged robot, ATRIAS, matches the SLIP model CoM trajectory (Figure 2).

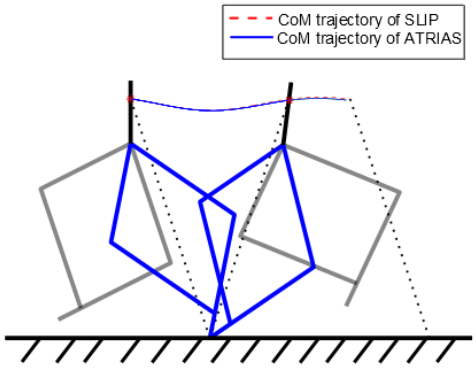

Figure 2: The SLIP model CoM trajectory and CoM trajectory of the full Lagrangian model of the robot.

5 Best Possible Outcome

By enabling the SLIP model on practical robots like ATRIAS, we can put the vast literature on SLIP model control to practical use.

Acknowledgement

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References

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