Efficient walking of the quadruped using passive linear spring

Pramod Pal[1], Shishir Kolathaya[1] and Ashitava Ghosal[1]

Indian Institute of Science, Bangalore, India[1]
{pramodpal,shishirk,asitava}@iisc.ac.in

1 Introduction

Quadruped robots have garnered considerable interest due to their potential in various applications. The design components of a quadruped, such as link design, actuation and control systems, compliant foot and sensors, play a crucial role in achieving efficient and stable locomotion. An essential component of attaining efficient walking in quadrupeds is the design of compliant feet that allow the quadruped to absorb impact forces and store and release energy with each step. In an earlier work, we have developed a design of a leg for a quadruped with a linear passive spring in foot. Through a combination of rigid body simulations and experiments, we were able to demonstrate that the range of values of the spring constant at the leg resulted in the highest hopping height, outperforming legs equipped with spring systems with either higher or lower stiffness[1]. These results highlight the significance of selecting the optimal linear spring configuration for efficient locomotion in quadrupeds. In this work, we extend the idea of a linear spring in the legs to all the legs of a qudruped and perform simulations in MuJoCo – a multi-body simultion platform where contact/impact of the leg with a ground, the kinematics and dynamics of the legs, torso and other links of a quadruped can be modeled and taken in to account for simulations[2]. One of the key preliminary result is that the designed (and modeled) quadruped can traverse a longer distance when there is a linear spring in the foot as compare to a quadruped where the legs are "rigid" with no springs.

2 Simulation results

As mentioned earlier, we have now designed a quadruped with each leg containing a linear spring. The trajectory traced by a foot of the quadrued is shown in Fig. 3a and it can be seen that the trajectories are similar (bit not exactly same) with and without a spring in the leg. The quadruped is made to undergo a trotting gait – front and hind legs on opposite sides move together. Simulations are done for about 10000 time-steps and the forward motion of the quadruped in shown in Fig. 3b. It can be clearly seen that quadruped traverses (on a flat ground) more distance when there is spring in the leg – 4 m versus 2 m when there is no spring.

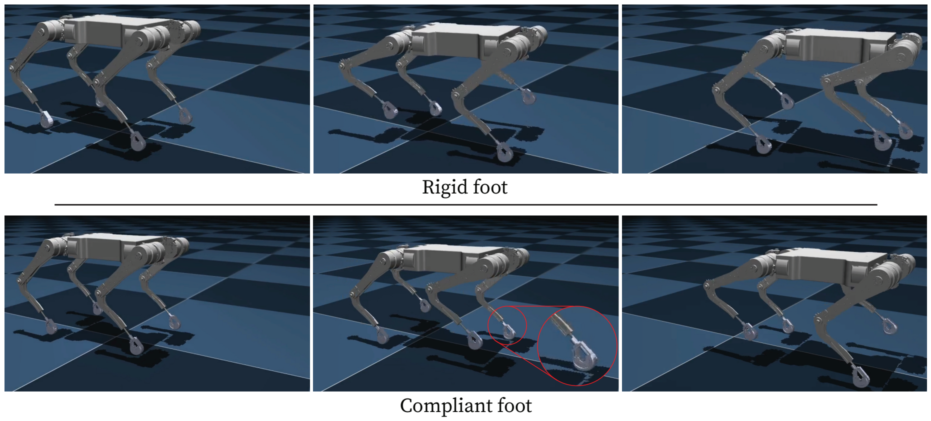

Fig. 1. Snapshot of motion of quadruped

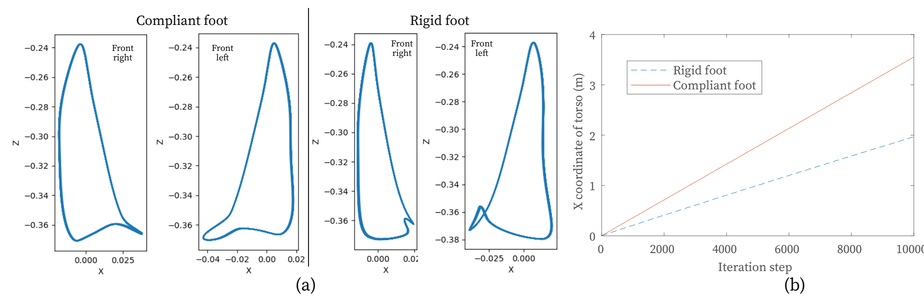

Fig. 2. (a)Trajectory of foot (b)Distance traveled by quadruped

3 Conclusion

This work deals with simulation of a quadruped with and without a spring(compliance) in the leg. Preliminary results show that the quadruped with compliance can travel a longer distance as compared to a quadruped with rigid foot. The work is continuing and will be validate with hardware results in future.

References

1. Pramod Pal, Anubhab Dasgupta, Avinash Bhashkar, Shishir Kolathaya, and Ashitava Ghosal,Efficient Robot Hopping Mechanisms with Compliance using Evolutionary Methods.In: Proc of 32nd International Conference on Robotics in Alpe-Adria-Danube Region, Springer Nature, Bled, Slovenia (2023, Accepted)
2. Todorov E, Erez T, Tassa Y. Mujoco: A physics engine for model-based control. In2012 IEEE/RSJ international conference on intelligent robots and systems 2012 Oct 7 (pp. 5026-5033). IEEE.