How one might realize practical, energy-efficient legged robots: lessons from the Cornell Ranger project

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1 Abstract

Human walking is considered relatively energy effective (energy metric **T**otal **C**ost **O**f **T**ransport, defined as energy used per unit weight per unit distance moved is about 0.3) and robust (like 0-2 falls a year) and super-reliable (works all the time). In comparison, walking robots are still energy hungry and unreliable. Some robots, like passive dynamic robots, are highly energy-effective (TCOT around 0.05) but fall down all the time, while others like PETMAN, ASIMO are reasonably robust and reliable but use lots of energy (TCOT of 2 or more). We present our robot called the Cornell Ranger [1, 2] (see figure 1) in this context.

Cornell Ranger is a relatively simple (it has only 4 degree of freedom), essentially planar, 1 m tall, knee-less bipedal robot that was custom built at BioRobotics Lab at Cornell University. So far it has achieved two feats in two separate trials, 1) It walked 65 km non-stop on a single battery charge, setting a legged robot distance record, and 2) It walked stably with a TCOT of 0.19, apparently less than that of any other legged robot to date.

We present some aspects of design and control that helped us achieve high energy-efficiency, high reliability and modest amounts of robustness on the Ranger. It is our hope that the lessons learned from this project will extend to more complicated practical legged robot systems.

2 Keywords

Experiment bipedal robot, Energy-efficiency, Reliability.

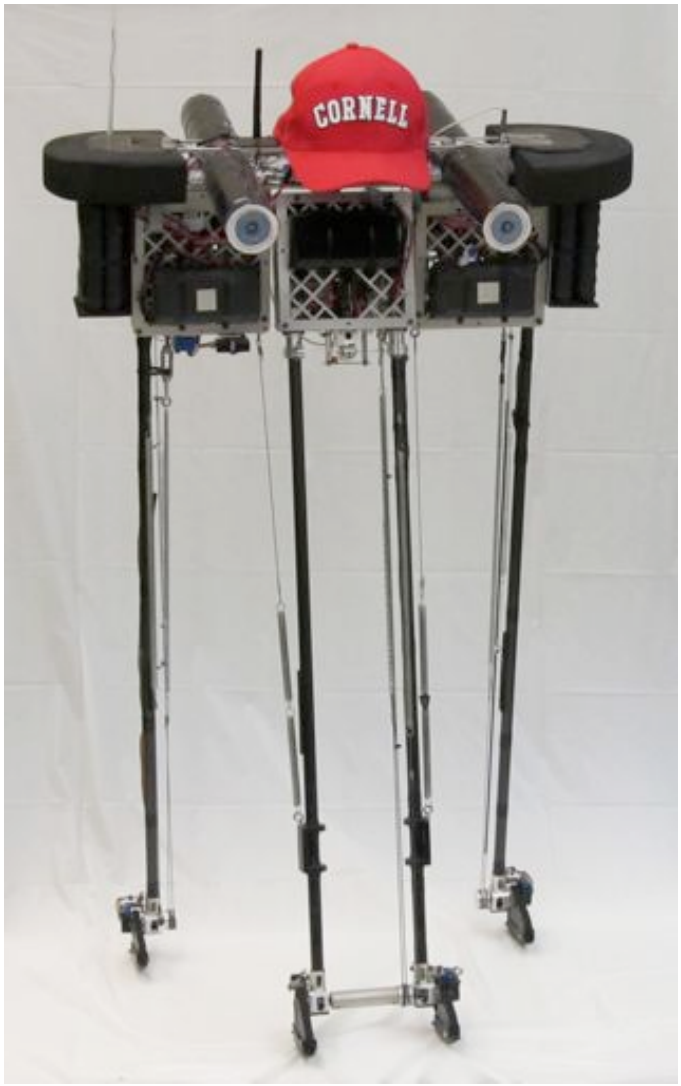

Figure 1: Photo of Cornell Ranger

References

[1] P. A. Bhounsule, J. Cortell, B. Hendriksen, J. G. D. Karssen, C. Paul, A. Ruina , A robot that walked 65 km on a single charge: energy-effective and reliable locomotion using trajectory optimization and stabilization from reflexes, *Submitted to The International Journal of Robotics Research*, 2012.

[2] P. A. Bhounsule, *A controller design framework for bipedal robots: trajectory optimization and event-based stabilization*, PhD Thesis, Cornell University, 2012.