Passive Energy Recovery Add-On Design Inspired by the Ostrich Tendon

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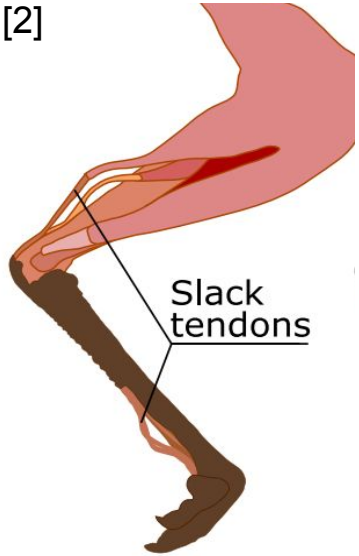
Design Inspired by Ostrich Leg

[1]

Ostrich

[2]



Ostrich leg structure

Fastest running birds[3]

- 43 miles per hour.[1]
- 10 to 16 feet for one stride.[1]

Why so fast？

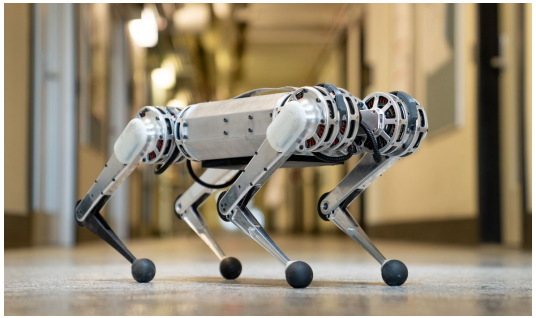
- **Tendon**
  - Work like springs or rubber bands
  - Switch slack into a loadable
  - Distribute the load
  - Release and stored energy

[2]“BirdBot achieves energy-efficient gait with minimal ... - science robotics.” [Online]. Available: https://www.science.org/doi/10.1126/scirobotics.abg4055. [Accessed: 14-Feb-2023].

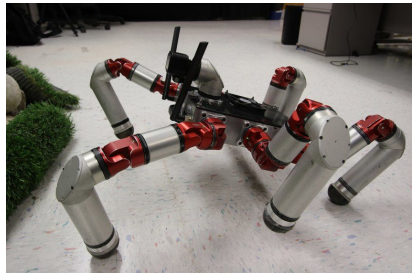
Background – Development of Legged Robot

[1]

[2]

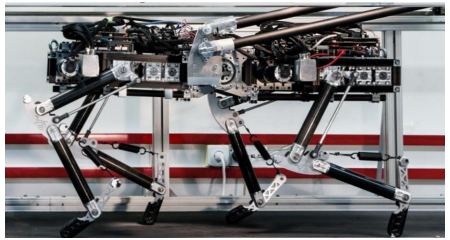


[3]



Different Configuration

[5]



Energy Recovery

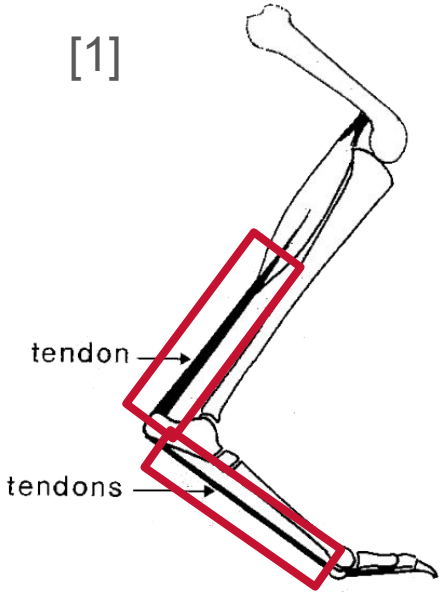
[4]

Dynamic Motion

Incorporating springs into the leg design allows legged robots to jump with less energy.

+

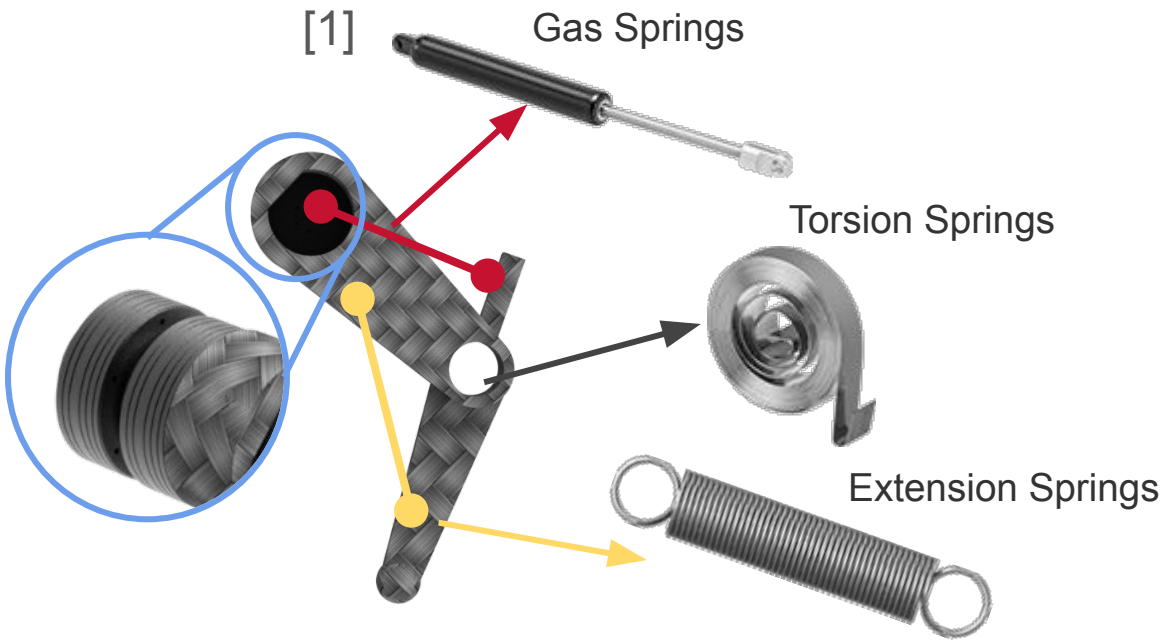
[1]

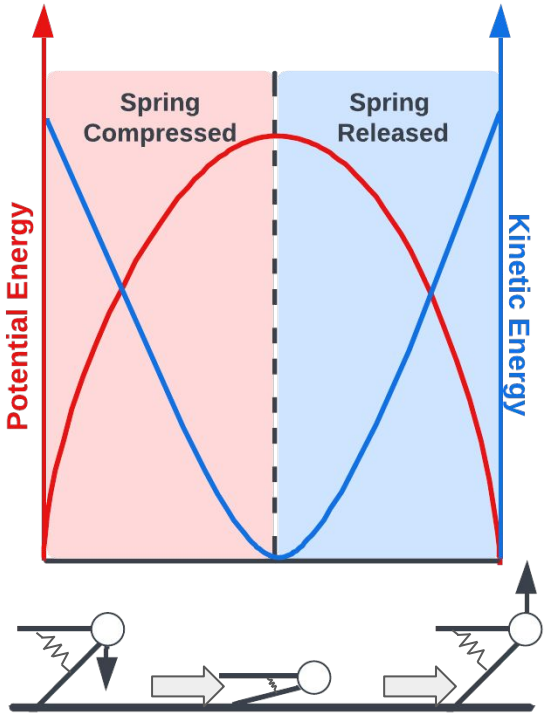


= ↑ Efficiency?

[1] R. Alexander and Others, ‘Three uses for springs in legged locomotion’, International Journal of Robotics Research, vol. 9, no. 2, pp. 53–61, 1990.

The design use springs as a substitute for tendons to store kinetic energy

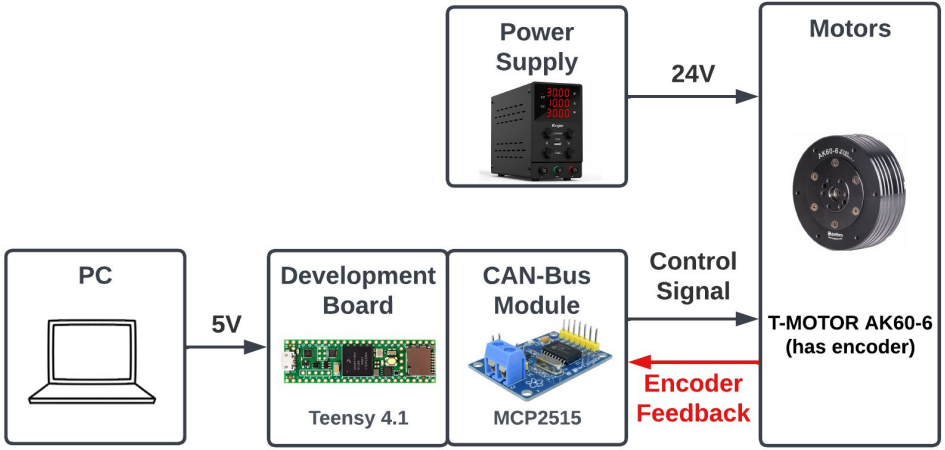




[1]“Carr,” McMaster. [Online]. Available: https://www.mcmaster.com/springs/. [Accessed: 13-Feb-2023].

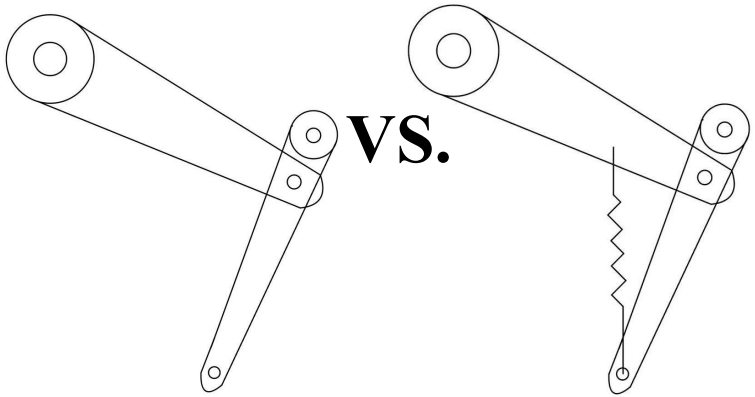
TBD

Electrical System Design

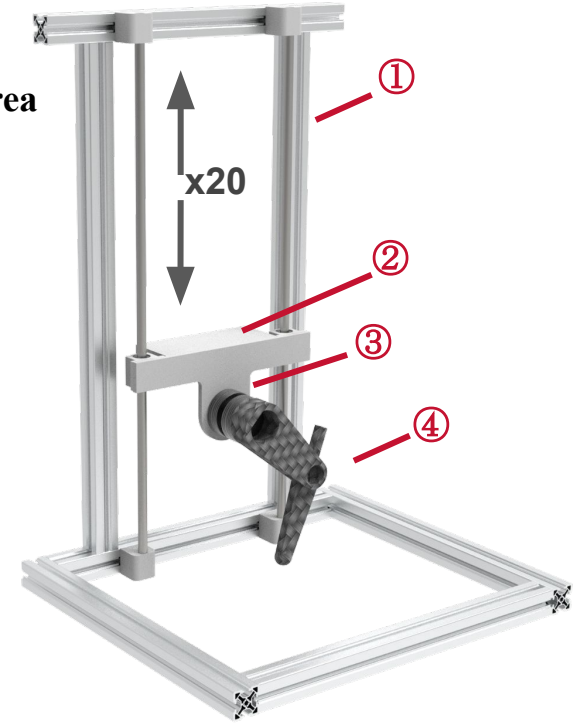


Control Framework Design

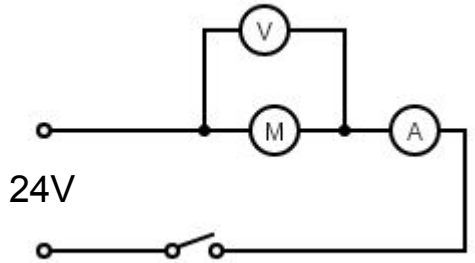
The experiment aims to optimize the efficiency of robot leg jumping by adding spring between thigh and calf



① Motion shafts
② Weight placing area
③ Motor
④ Robot leg



The experiment evaluates the power consumption of actuator using voltage and current data



$$E = \int_{t_0}^{t_e} I \cdot U \, dt$$

Question?

Reference

[1] GTrobotics, ‘Cmu Leg Lab’, YouTube. YouTube, Jul-2016.

[2] Jennifer Chu | MIT News Office, “Mini cheetah is the first four-legged robot to do a backflip,” MIT News | Massachusetts Institute of Technology. [Online]. Available: https://news.mit.edu/2019/mit-mini-cheetah-first-four-legged-robot-to-backflip-0304. [Accessed: 12-Feb-2023].

[3] British Museum Dept of Egyptian and and L. W. }Q }DKing, Babylonian boundary-stones and memorial-tablets in the British museum. Legare Street Press, 2022.

[4] BostonDynamics, ‘Atlas | Partners in Parkour’, YouTube. YouTube, Aug-2021.

[5] K. Koutsoukis and E. Papadopoulos, "On the Effect of Robotic Leg Design on Energy Efficiency," 2021 IEEE International Conference on Robotics and Automation (ICRA), Xi'an, China, 2021, pp. 9905-9911, doi: 10.1109/ICRA48506.2021.9560997.

[6] R. Alexander and Others, ‘Three uses for springs in legged locomotion’, International Journal of Robotics Research, vol. 9, no. 2, pp. 53–61, 1990.