Quadrupedal Bio-inspired Robots: Development & Characteristics

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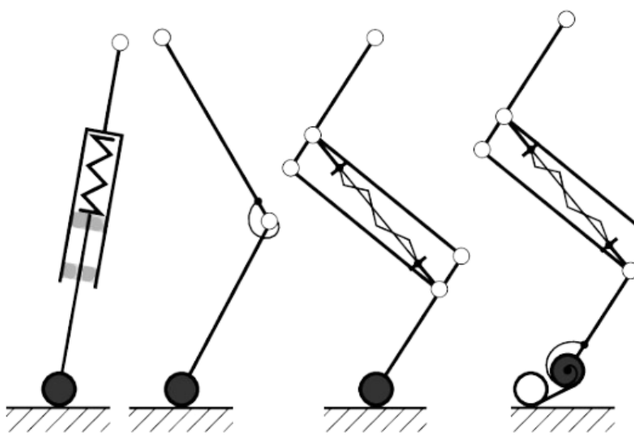
Abstract

In the last decade, we have seen major advancements in the area of quadruped robots and many promising efforts are setting out to help humans by replacing them in performing dangerous, dull, or unclean tasks. Drawing inspiration from nature, robotics engineers have set out to achieve similar dynamic locomotion capabilities in legged machines through what is called bio-inspiration. The motivation behind this review is to summarize and consider previous research efforts and provide useful guidance for future robotic design novelties towards more efficient quadruped robots. Essential characteristics for the realization of the quadrupedal system are being discussed, focusing on actuation and mechanical leg design methods. Particularly, this state of the art project also facilitates the role of the reader gaining a better understanding on the robotic paradigms that already exist in the market or are part of academic bibliography, contributing in design research purposes. At the same time, novelty suggestions in the field were presented, posing particular interest for future implementations in the space of Open Source projects.

Mechanism

The biological skeleton of mammals has motivated the structure of several quadrupeds. The type synthesis of leg architecture can be classified into the following categories:

- Prismatic Legs
- Mammal Type Articulated Legs
- Sprawling Type Articulated Legs
- Redundant Legs



Actuation

Legged locomotion introduces unique challenges to the process of actuator design.

The decisions taken regarding the actuation of the robot places unique demands on both the performance specifications and passive mechanical characteristics. In order to satisfy the condition of high output torque, different types of high power density actuators have been created:

- Hydraulic actuators
- Quasi-direct drive actuators (QDD)
- Serial Elastic Actuators (SEA)

Conclusions

It is crucial to balance the relationship between agility and overall structural quality.

The increase of structure thickness functions as a solution to high stress on the robot's legs but at the same time, this would result in high inertia that limits the rapid swing of the leg. and consequently, reduces the agility of the quadruped.

In contrast, increasing the actuator power solves the problem to some extent but the increased actuator weight could prove to increase the overall inertia and also affect the agility of the leg. The solution to this challenge would be to reduce the leg's inertia with suitable leg design solutions.