Quadruped Robotics

Introduction And Design Inspiration:

Quadruped robots have a high load carrying capacity and better stability than biped or humanoid robots. Compared with multi-legged systems, they have broader leg space, less mechanism redundancy, and a lower level of complexity but also lower stability. Due to the emergence of AI and machine vision, the applicability of mobile robots is increasing significantly. Mobile robots can be classified into wheeled robots, tracked robots, and legged robots. Even after many technological advancements in wheeled and tracked vehicles, their mobility is limited to plain and less rough terrains.

Various quadruped legs:

• **Rigid legs**: Rigid legs are the simplest leg design and consist of solid links connected by joints (usually rotary joints). They are sturdy and straightforward, making them suitable for applications with relatively flat terrain (Tedeschi and Carbone, 2014).

• **Articulated legs:** Articulated legs have multiple segments connected by joints, allowing more degrees of freedom. These legs provide enhanced flexibility and can navigate uneven terrains and obstacles effectively (Tsitsimpelis et al., 2019).

• **Parallel mechanism legs:** Parallel mechanism legs use multiple linkages connected in parallel, providing increased stability and load-carrying capacity. These legs are often used in heavy-duty applications or scenarios where stability is critical (Wang et al., 2013).

• **Insect-like legs:** Inspired by insect locomotion, insect-like legs have joints and segments that mimic the movements of real insects. They offer high agility and adaptability to complex terrains (Roennau et al., 2013).

• **Multi-degrees of freedom (DOF) legs**: Multi-DOF legs have more than three degrees of freedom, enabling sophisticated movements and better grasping capabilities. These legs are often used in research and advanced robotics applications (Hashimoto, 2017).

• **Spring-loaded legs:** Spring-loaded legs use mechanical springs to absorb shocks and vibrations during locomotion. They are suitable for rough terrains and can provide smoother movements (Mooney and Johnson, 2014).

• **Hydraulic/pneumatic legs:** Some hexapod robots use hydraulic or pneumatic actuators in their legs for enhanced power and load capacity. These legs are commonly found in heavy-duty industrial applications (Suzumori and Faudzi, 2018).

• **Passive compliance leg:** Passive compliance legs use flexible materials or mechanisms to allow a certain level of compliance during environmental interactions. This compliance helps prevent damage to the robot and enhances safety.

• **Bio-inspired legs:** Biomimetic or bio-inspired legs take inspiration from the anatomy and movement of animals, such as mammals or arthropods. These legs often improve performance in specific environments, such as climbing or swimming (Vidoni and Gasparetto, 2011).

• **Wheeled–leg hybrid**: Some hexapod robots feature legs with integrated wheels, providing both legged and wheeled locomotion options. This design allows the robot to switch between walking and rolling modes based on the terrain (Sun et al., 2017; Bai et al., 2018).

Varieties of quadruped locomotions.

Link: https://www.frontiersin.org/journals/mechanical-engineering/articles/10.3389/fmech.2024.1448681/full

Ladder-climbing robot for vertical tower applications: