

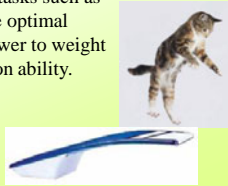
Dynamic Tasks of a Hydraulically Actuated Quadruped Robot

Claudio Semini, Nikos Tsagarakis, Darwin Caldwell
Italian Institute of Technology, Genoa, Italy

Introduction

The current research focuses on the development of a quadruped robot platform that is able to perform highly dynamic tasks such as running and jumping. Electric motors are not the optimal actuator type for these tasks, due to their low power to weight ratio, necessity for gears and poor heat dissipation ability.

Hydraulic actuation provides an interesting alternative, as it has a great power to weight ratio, is highly responsive and allows easy joint force/torque measurement.



Quadruped Robot Design

• General Description:

Biologically inspired, energy-autonomous quadruped robot able to walk, run and jump.

• Size:

Like large size dog, height less than 1 meter, comparable to *Irish Wolfhound* or *Great Dane*



• Weight:

Around 60 kg + 10 kg payload

• Actuation:

Double-acting hydraulic oil cylinder controlled by proportional spool valves for each degree of freedom.



• Energy Supply:

On-board internal combustion engine for several hours of energy- autonomous operation.

• Leg Configuration:

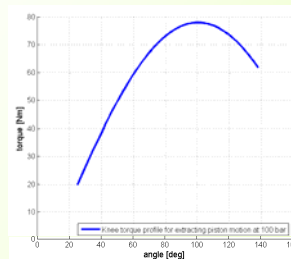
Bio-inspired X-configuration: "the elbow points to the knee"



Design of Leg-Prototype

Specifications

- 3 active degrees of freedom:
 - 2 in sagittal plane (hip + knee)
 - 1 in frontal plane (hip sideways)
- Limb lengths: 300mm each
- Weight including cylinders: 4.5 kg
- Max force of extracting piston at 160 bar: 3200N
- Sensors per degree of freedom: Rotary encoder, load cell
- Lever length of joints: 39 mm



Design of Experiments

- Linear guide (nylon bushings) for vertical motion
- Oil pressure: 100 bar
- Oil type, temperature: VG46, 70 degC
- Foot trajectory: vertical motion following a sine wave
- Stiffness of mechanical spring in foot: 12 kN/m



Experimental Results of Vertical Jump



Picture sequence of the HyQ leg prototype clamped to the vertical slider test bench, performing a vertical jump motion. Time between two frames: 0.16 seconds.