Design of a Passive Compliant Leg For a Hexapod Robot

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Introduction

- When legged robots are required to perform tasks like running, the compliance of the legs becomes important.

Figure 1: Two samples of legged robots [http://www.bostondynamics.com]

- We have designed and constructed a passive compliant leg for a hexapod robot
- Recent research shows that the performance of this robot design can be influenced significantly by leg compliance [1].
- Have a design to independently study the effects of leg compliance in the vertical direction and in the fore-aft direction.
- Study the complete kinematics of the legs by attaching a sufficient number of motion tracking markers to the leg structures
- The design prioritizes manufacturability, as the majority of leg components were fabricated from materials commonly available in hardware stores, without specialized machining tools.

Motivation

- Leg stiffness has a significant impact on the legged robot's speed and efficiency [2].
- Adjusting leg stiffness adapted for physical parameters for improving the stability performance is more efficient than those obtained by optimizing the controller [2]
- Trying to fabricate an stiffness adjustable leg for BIRD's hexapod (a modular robot with passive legs) to get a good performance in different gaits

How to Design a Passive Compliant Leg

Design Criteria

- adjustable stiffness in the vertical and fore-aft directions of the leg to investigate the role of legs stiffness on the locomotion performance in different gaits.
- Capability of attaching markers in the key points of the leg structure to study the hole kinematics of the leg
- Using usual materials and machining processes in fabrication of the leg

Conceptual Design:

- adjustable length of spring steel strips lets us to have adjustable stiffness in the vertical and fore-aft directions .
- using Aluminum bar as a solid part and ABS plastic for connecting part

Detail Design

- Doing stress-strain analysis to find an optimum size of the metal and ABS parts

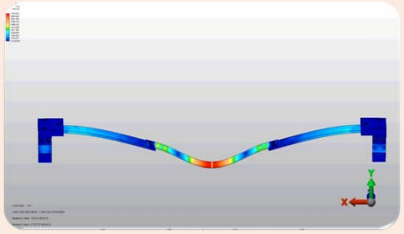
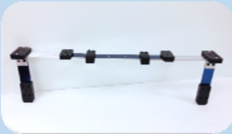


Figure 2: stress-strain analysis of the designed leg

- Also, Adjust the thickness of the spring steel to have a proper static load deflection (~10% height decrement)

Discussion

Leg specifications

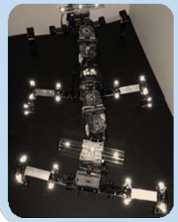


Range of fore-aft stiffness: 440-1200 N.m

Range of vertical stiffness: 75-1500 N.m

Weight of each leg: 0.75lb (340 gr)

Fabrication



Each leg can be fabricated less than 15 hours

Using only Aluminum bar, ABS sheet, and Spring Steel strip

Required machining process: Laser cutting, Drilling, metal cutting

References

1- J. Sastra, S. Revzen, and M. Yim. Softer legs allow a modular hexapod to run faster. In Climbing and Walking Robots, 2012.

2- K. C. Galloway, et al, "Experimental Investigations into the Role of Passive Variable Compliant Legs for Dynamic Robotic Locomotion," in IEEE Int. Conf. on Robotics and Automation, 2011.

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