

Accepted Manuscript

Title: Model-based feedforward and cascade control of hydraulic McKibben muscles

Author: Michael Meller Boris Kogan Matthew Bryant Ephraim Garcia



PII: S0924-4247(17)31199-8
DOI: <https://doi.org/doi:10.1016/j.sna.2018.03.036>
Reference: SNA 10702

To appear in: *Sensors and Actuators A*

Received date: 30-6-2017
Revised date: 1-3-2018
Accepted date: 23-3-2018

Please cite this article as: Michael Meller, Boris Kogan, Matthew Bryant, Ephraim Garcia, Model-based feedforward and cascade control of hydraulic McKibben muscles, *Sensors & Actuators: A. Physical* (2018), <https://doi.org/10.1016/j.sna.2018.03.036>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Model-based feedforward and cascade control of hydraulic McKibben muscles

Michael Meller^{a,*}, Boris Kogan^a, Matthew Bryant^b, Ephraim Garcia^{a,1}

^a*Laboratory for Intelligent Machine Systems, Sibley School of Mechanical and Aerospace Engineering, Cornell University, Ithaca, NY 14853-7501, USA*

^b*Intelligent Systems and Structures Research Lab, Department of Mechanical and Aerospace Engineering, North Carolina State University, Raleigh, NC 27695-7910, USA*

Abstract

McKibben artificial muscle actuators are predominantly pneumatically powered. Recently, hydraulic operation has gained interest due to its higher rigidity and efficiency. While there has been extensive control system development for pneumatic artificial muscles, little has been conducted hydraulically. This paper investigates three different controllers developed for a loaded robotic arm actuated with oil-hydraulic McKibben muscles. The goal was to achieve good angular position tracking over a range of frequencies up to 1 Hz. The first scheme, serving as the baseline, is a proportional-integral controller. The second architecture adds a nonlinear model-based feedforward term to the baseline controller; the feedforward includes the expected flowrate demands based on the actuator kinematics as well as the valve flow gain. The last scheme adds an inner pressure feedback loop to the second architecture. All controllers were evaluated with frequency and step response experiments. The results show that a simple proportional-integral controller has significant phase lag and attenuation at the higher frequencies tested; including the feedforward term almost completely eliminates these. The cascaded loop improves rise and settling times.

Keywords: McKibben muscle, fluidic artificial muscle, hydraulic artificial muscle, fluid power control, hydraulic control, robotics

*Corresponding author

Email address: mam627@cornell.edu (Michael Meller)

¹Deceased.

Download English Version:

<https://daneshyari.com/en/article/7133401>

Download Persian Version:

<https://daneshyari.com/article/7133401>

[Daneshyari.com](https://daneshyari.com)