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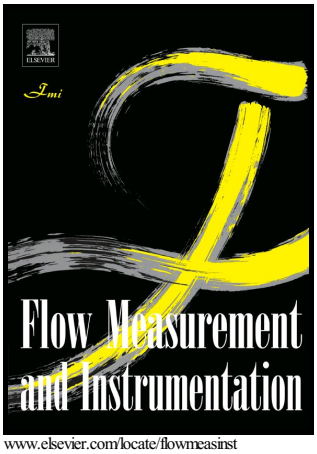

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PII: S0955-5986(16)30092-9
DOI: http://dx.doi.org/10.1016/j.flowmeasinst.2016.08.001
Reference: JFMI1236

To appear in: *Flow Measurement and Instrumentation*

Received date: 29 February 2016
Revised date: 27 July 2016
Accepted date: 3 August 2016

Cite this article as: Jiaoyi Hou, Zengmeng Zhang, Dayong Ning and Yongjun Gong, Model-based Position Tracking Control of a Hose-connected Hydraulic Lifting System, *Flow Measurement and Instrumentation* http://dx.doi.org/10.1016/j.flowmeasinst.2016.08.001

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Model-based Position Tracking Control of a Hose-connected Hydraulic Lifting System

Jiaoyi Hou, Zengmeng Zhang, Dayong Ning, Yongjun Gong[1]

Transport Equipment and Ocean Engineering Department, Dalian Maritime University, China

Abstract

High-pressure rubber hose is normally used to connect the control valves and actuators of hydraulic systems and thus lower their natural frequency. PID control is preferred in industrial hydraulic systems as it has many advantages over other controls. However, the low natural frequency of hose-connected systems limits the performance of PID control. In this paper, a hose-connected hydraulic lifting test rig is presented and the mathematical model of the system is proposed. Valve compensation strategy and hose compensation strategy are designed based respectively on the flow characteristic of the proportional valve and the mathematical model of the hose. Comparative experiments with typical desired trajectories are carried out in the test rig. Results show that both the compensation strategies are effective in improving the tracking accuracy.

Keywords: electro-hydraulic system; valve compensation; hose compensation; valve-controlled system; model-based control; lumped parameter model

1. Introduction

Hydraulic transmission systems are widely used in engineering applications, especially in the field of automation and heavy-duty machinery. They offer fast response and high stiffness and maintain precise tracking performance under varying loads [1]. Equivalent bulk modulus, which affects the hydraulic natural frequency, is an important parameter of the hydraulic system [2]. In a hydraulic system, the equivalent bulk modulus is a combined effect of the bulk modulus of the air-oil mixture and the container.

In the majority of mobile machinery, actuators move relative to the machine, such as the bucket cylinder of the excavator, the rotating motors, and the lifting cylinders of the forging manipulator. In these conditions, high-pressure rubber hoses with outside sheaths of stainless steel are widely used because of their good flexibility. The rubber hoses have a comparatively low bulk modulus, which lowers the equivalent bulk

[1] *Corresponding author: Transport Equipment and Ocean Engineering Department, Dalian Maritime University, Dalian, 116026, China. Tel.: +86 411 84725229; Fax: +86 411 84725960*

E-mail address: yongjungong@163.com.

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