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AIMS AND SCOPE

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A PRECISION DRVING SYSTEM COMPOSED OF A HYDRAULIC CYLINDER AND HIGH-SPEED ON/OFF VALVES

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Abstract

In manufacturing technology, the predominant tendency in recent years has been for machine tools, for example, turning-, milling-, and drilling-machines, to employ electrically operated actuators such as a servo-motor equipped with a ball screw. There are, however, various problems with these electric driving systems; they are excessively large-sized with complex machinery, and their application is expensive, as seen, for example, in the case of the NC-machine. In order to solve these problems, this study aims to develop a precision driving system actuated by a hydraulic cylinder. The hydraulic driving system consists of a cylinder and four ON/OFF solenoid valves. The valves are the same as those used in a fuel injector of an automobile, which are capable of high speed switching, as fast as 1.5 ms. It was confirmed in experiments that the developed system had a moving resolution of 1.2 μm and, as a result, was applicable to a precision driving table for micro-processing.

Keywords: hydraulic driving table, on/off control system, on/off valve, precision processing, micro-processing machines

A NEW EXPERIMENTAL ALGORITHM FOR THE EVALUATION OF THE TRUE SONIC CONDUCTANCE OF PNEUMATIC COMPONENTS USING THE CHARACTERISTIC UNLOADING TIME

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Abstract

In this paper an alternative method for obtaining the sonic conductance of pneumatic valves, *C*, is presented. The method uses the characteristic unloading time defined in a transitory discharge process and supposes an experimental cost lower than the ISO 6358 procedure. With this method the test rig needed is not so large and a precise measure of the variables involved in the discharge, pressure, mean temperature or specific volume, is not required either. Furthermore, the author has found experimentally that *C* depends on the geometric factor *L*/*D* of the chamber that impulses the mass flow rate and not only on the effective section *A* of the valve element. The sonic conductance obtained by the characteristic unloading time method is smaller than the obtained by the ISO 6358, and finally explains some experimental points. Firstly, the effective mass flow through some valves is significantly inferior to the one expected when considering the *C* ISO estimation. And secondly, it looks like if the valve would conduce a different mass flow depending on the system to which it is connected.

Key words: sonic conductance, mass flow rate, pneumatic valves and nozzles, characteristic time

COMPARISON OF CAVITATION EROSION TEST RESULTS BETWEEN VIBRATORY AND CAVITATING JET METHODS

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Abstract

The relationship between the vibratory and cavitating jet test methods was determined experimentally. Six metallic specimens were made of aluminum alloy, superduralumin, high-strength brass, stainless steel, carbon steel and chromium-molybdenum steel. The specimen surface was eroded as fine and uniform pattern with the vibratory method, but was rough and ring-shaped with the jet method. Striation and plastic deformation were clearly observed in the specimens eroded by jet cavitation. The volume loss was the largest for aluminum alloy, followed by superduralumin, high-strength brass and steel. Both test methods yielded the same descending order for the volume loss. The ratio of volume loss by the vibratory method compared to the cavitating jet method became constant as the time proceeded.

Keywords: cavitation, erosion, jet, vibratory, water, metals

MEASURED PERFORMANCE EVALUATION OF PID AND NEURAL NET CONTROL OF A HYDRAULICALLY DRIVEN INERTIA LOAD WITH NONLINEAR FRICTION

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Abstract

Hydraulic systems are inherently nonlinear. When used to control an inertial load, which also exhibits nonlinear behaviour due to slip-stick friction at the contact surface, the result is a system which is highly non-linear and poses a difficult control problem. The study described in this paper examines the experimental performance of velocity control of a mass on a sliding contact surface using a servovalve and linear actuator. Conventional PID control is compared to artificial neural net (ANN) based controllers. A modified multi-input PID controller was used to train the ANN controller. The ANN based controller outperformed the PID controller when subjected to a wide variety of input signals. A second ANN co-controller was added to the loop to provide an additional corrective signal in the form of a pulse to give the system an extra surge of input to overcome the stiction friction in the zero velocity cross-over region. Excellent results were achieved with improved accuracy compared to the single ANN controller when subjected to a series of random input signals, indicating the robustness of the ANN controllers.

Keywords: hydraulic, PID, neural network, control, nonlinear

A FUZZY NEURAL NETWORK APPROACH TO MODEL HYDRAULIC COMPONENT FROM INPUT/OUTPUT DATA

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Abstract

The dynamics of hydraulic components are vital for the virtual prototyping of fluid power systems. This paper proposes a fuzzy neural network approach to model the behavior of a hydraulic component from its input-output. The main advantage of this approach is that the network structure can be determined based on the analysis of the input variables to output response, without trial and error, network pruning or network growing techniques. The process involves resolving the significant inputs through an analysis of their effects with respect to the output. The number of fuzzy rules is determined based on partitioning the input-out space. The number of significant inputs and the number of fuzzy rules together defined the fuzzy neural network structure. A hydraulic pressure relief valve is used to demonstrate the proposed approach. The results indicate that the structure of the fuzzy neural network determined based on the proposed approach can effectively model the dynamics of the relief valve. This work constitues initial effort towards determining the structure of neural networks based on the analysis of input-output data.

Keywords: fuzzy neural network (FNN), fluid power system, virtual prototyping.