The Summer Undergraduate Research Fellowship (SURF) Symposium
4 August 2016
Purdue University, West Lafayette, Indiana, USA

CONTROL SYSTEM RESEARCH AND DEVELOPMENT TO SUPPORT VIRTUAL PROTOTYPING OF PUMP AND MOTORS

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ABSTRACT

Virtual prototyping of positive pumps and motors is incredibly useful, increasing speed of development and lowering cost. The calculations of fluids discharge pressure, displaced by a swashplate-type-axial piston pump/motor is dependent on the load impedance driven by the unit. The load impedance is estimated by a variable orifice found downstream of the unit. Similarly, the suction line impedance is also estimated with an orifice. The current project aims to evaluate the various loading architectures in their ability to quickly and accurately create the desired impedance. The robustness of the loading architectures was tested on a wide range of pump sizes, speeds, pressures, and displacements.

The estimated initial conditions of the loading architectures, such as the orifice areas and line volumes and pressures are very efficient means of converging to the correct discharge pressure. To develop a model, based on past simulation, a full factorial design of experiments (DOE) was performed to generate the required training data set. The DOE revealed the models sensitivity to the normally unknown variables which contributed to large variations in accuracy.

However, after analyzing the impact of other variables, an alternate approach was taken. By creating a variant of the simulation, which sets port pressures equal to line pressures, orifice areas can be effectively removed from the equation. In order to compare the performance, ideal valve plates specific to each code variant should be used. This is because arbitrary valve plates may favor one over the other, yielding extraneous conclusions. An existing genetic algorithm found the accuracy was unaffected while greatly improving speed.

KEYWORDS

Hydraulics, controls, programming, gain scheduling, PID, design of experiments