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Design of model predictive force control for hydraulic servo system based on cuckoo search and genetic algorithms

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Abstract

This article discusses a system identification based on a black-box state-space model for an experimental electro-hydraulic servo system. Furthermore, it presents force-tracking control for the electro-hydraulic servo system based on model predictive control. The parameters of model predictive controls have been tuned by cuckoo search algorithm as well as genetic algorithm. The realization of model predictive controls depends on using a data acquisition card (NI-6014) and Simulink/MATLAB as the core of the electro-hydraulic servo system control system. In this research, the combination of model predictive control tuned by cuckoo search algorithm and genetic algorithm has been introduced in the form of switching model predictive controls. This combination collects the advantages of two model predictive controls in one model predictive control by switching model predictive controls. The simulation and experimental results display that the suggested switching of model predictive controls introduces a good tracking performance in terms of settling time, rise time, and system overshoots as compared to the two separated model predictive controls. In addition, the experimental evaluation has shown that the proposed switching model predictive controls achieved a stable and robust control system even facing to a different reference command signals (step, multistep, and sinusoidal signals). Moreover, its behavior is more robust for system parameters perturbation and small or large perturbation of disturbances in the working environment. It also achieves the necessitated physical limits of the actuator. As a general conclusion and a deep study of electro-hydraulic servo system, one can conclude that the switching strategy between model predictive control tuned by cuckoo search algorithm and by genetic algorithm has the priority of applying it on the field of electro-hydraulic servo system. The proposed new strategy (switching of model predictive control) is promising in experimental applications.

Keywords

Cuckoo search algorithm, force control, genetic algorithm, hydraulic servo system, model predictive control

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Introduction

Model predictive controls (MPCs) are a significant strategy in a wide range of process control applications. It has the ability of handling non-linearity and abnormal dynamics and constraints, especially in industrial control systems.[1] The main problem that most researchers face is to develop a good tuning method for MPC's parameters which affects the system behavior.[2] In addition, it is known that the trial and error tuning method can be quite time-consuming and can result in non-optimum tuning.[1,2] In an attempt to resolve this problem, a comparison of two tuning algorithms for MPCs has been studied in this research. These approaches include cuckoo search algorithm (CSA) and genetic algorithm (GA). In order to study the comparison between the two tuning methods for MPCs in a worthy way, it must be applied to a real industry-related experimental system. As a result, the selected system is an experimental system for electro-hydraulic servo system (EHSS). The EHSS is usually used in industries for

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