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Simulation and Design of Decentralized PI Observer Based Controller for Nonlinear Interconnected Systems of the Diesel Engine Airpath

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Abstract

During the development of ECU software, physical/environment model plays major role in simulation and prediction of engine behavior. Hence it is necessary to bring simulation results from the model as close as possible to the real environment. Once the model is mature enough it is used as a bench mark for designing a control strategy.

The present paper deals with the identification of most influencing parameters (MIP) for given operating condition to have a desired behavior of the airpath model. The airpath model is validated with reference model. Multi input multi output (MIMO) model is cross verified with recordings and the MIMO model is benchmarked. The author describes in detail the application of statistical study needed to arrive at a decision which is supported by the nature of outcome by having probabilistic studies of MIP.

A small signal analysis via perturbation is done on the model to check the stability and response of the system in steady state. The model with and without observer is simulated to check the performance of the model.

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Keywords: Observer; Engine Models; Control Systems.

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1. Introduction

Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 10 pt. Here follows further instructions for authors.

There are legion work done with conventional thermodynamic approaches, some of which are highlighted by Aguilera-Gonza [6], who developed a pressure model for diesel engine and proposed a Parallel Distributed Compensation Fuzzy controller be applied to regulate the intake and exhaust manifold pressures in a four-cylinder diesel engine air-path system accompanied with EGR and VGT. Junmin Wang [7], describes a hybrid robust nonlinear control approach for modern diesel engines operating multiple combustion modes; in particular, low temperature combustion and conventional diesel combustion modes. An innovative control system is designed to track different key engine air-path operating variables at different combustion modes as well as to avoid singularity which is inherent for turbocharged diesel engine running multiple combustion modes.

Observers use the plant input and output signals to generate an estimate of the plant's state, which is then employed to close the control loop. Observers are utilized to augment or replace sensors in a control system. The observer was first proposed and developed by Luenberger in the early sixties of the last century (Luenberger, 1966; 1971; 1979). Since the early developments, observers for plants with both known and unknown inputs have been developed resulting in the so-called unknown input observer (UIO) architectures, such as, for example, those in (Bhattacharyya, 1978; Chen and Patton, 1999; Chen et al., 1996; Corless and Tu, 1998; Darouach et al.).

Observers for systems with unknown inputs play an essential role in robust model-based fault detection (Chen and Patton, 1999; Edwards et al., 2000; Edwards and Spurgeon, 1998; Jiang et al., 2004; Saif and Xiong, 2003). The basic idea behind the use of observers for fault detection is to form residuals from the difference between the actual system outputs and the estimated outputs using an observer. Once a fault occurs, the residuals are expected to react by becoming greater than a prespecified threshold. When the system under consideration is subject to unknown disturbances or unknown inputs, their effect has to be decoupled from the residuals to avoid false alarms

In this paper, we present design procedures for full and reduced-order observers for systems with unknown system response. The unknown input can be a combination of un-measurable or unmeasured disturbances, unknown control action, or un-modeled system dynamics. Figure 1 shows the overall framework of the small signal model.

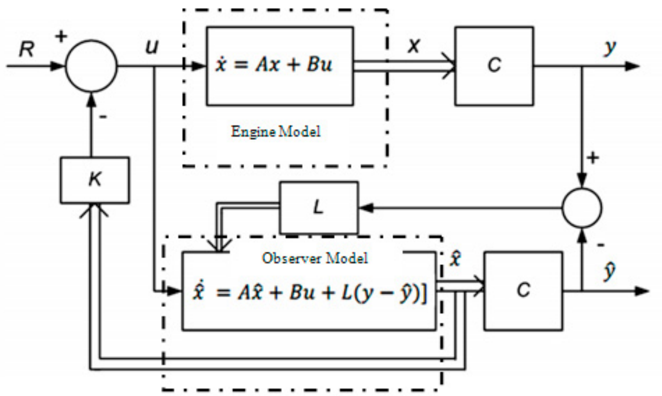

Figure 1 Framework for small signal model