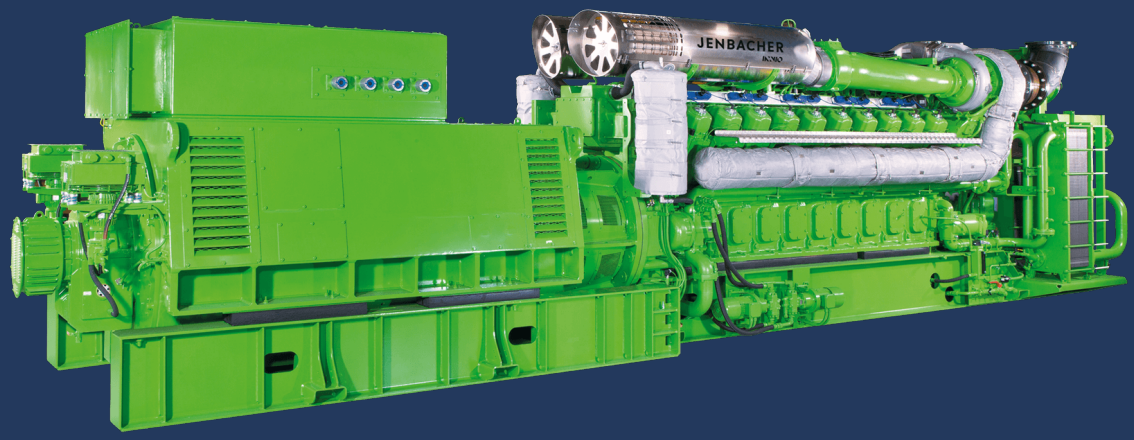
Control & Simulation Master Thesis

Controller Development and Transport Delay Characterization for Gas Engines in Island Mode Operation

Anton Marcel S. Hendrickx



TU Delft

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Controller Development and Transport Delay Characterization for Gas Engines in Island Mode Operation

Thesis report

by

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Abstract

The thesis, conducted in collaboration with INNIO Jenbacher GmbH & Co OG (INNIO), presents two investigations advancing industrial gas engine control systems. The first investigation develops and compares four control strategies for engine speed regulation: iterative Linear Quadratic Regulator (iLQR), pole placement, Nonlinear Dynamic Inversion (NDI), and Incremental Nonlinear Dynamic Inversion (INDI). Each controller was derived from INNIO nonlinear Jenbacher engine models and evaluated through simulation under consistent tuning methodology. The analysis emphasized multi-variable control coordination, cross-coupling effects, robustness against model mismatch, and practical implementation considerations for commercial deployment.

The second investigation establishes a comprehensive methodology for identifying and characterizing fuel transport delays using GT-SUITE/MATLAB co-simulation calibrated with Jenbacher engine data. Virtual sensors at multiple locations quantified delay behavior across load acceptance, rejection, and steady-state operating conditions. Quadratic models were developed to enable real-time delay prediction based on boost pressure and operating mode. Both investigations provide control-theoretic frameworks and empirical models directly applicable to INNIO's current and future engine platforms.

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