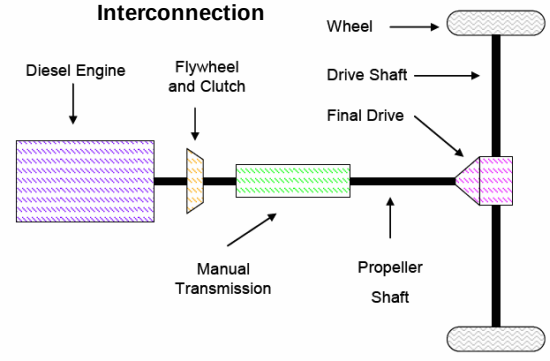
Automating Governor Calibration

Research Summary:

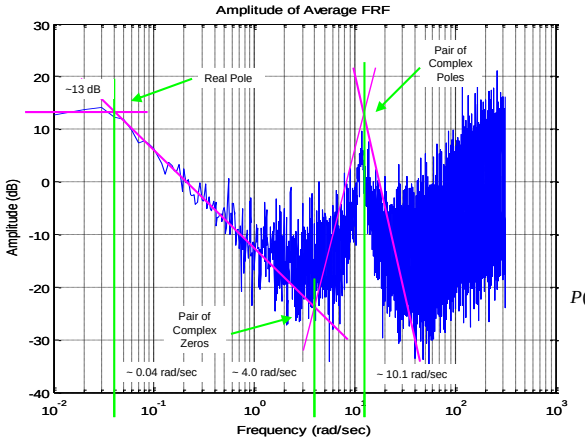
The objective of this research is to develop a systematic diesel engine PI governor design methodology independent of the application. The solution approach is to integrate online modeling and robust controller design in two steps: first, a system identification is performed in the four-step instrumental variable (IV4) method, and second, an adaptive controller is designed based on Quantitative Feedback Theory (QFT) and is executed on a Nichols Chart.

System Description

Diesel Engine and Vehicle System Interconnection



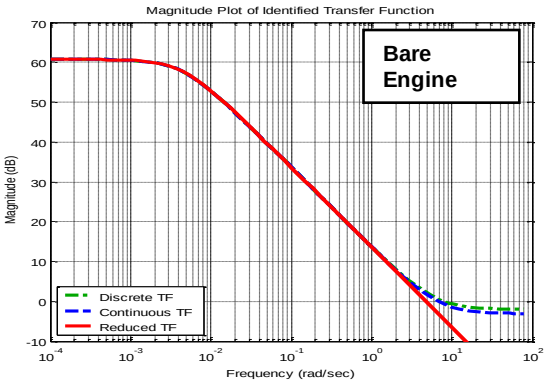
FRF of the System Model with 3.17 Gear Ratio

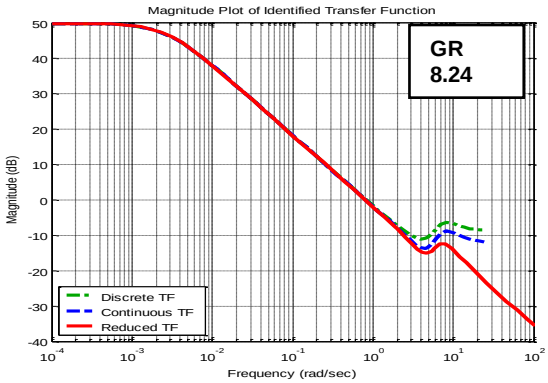


$$P(s) = \frac{K\left(\frac{s^2}{w_3} + \frac{2z_3 s}{w_3} + 1\right)}{\left(\frac{s}{w_1} + 1\right)\left(\frac{s^2}{w_2} + \frac{2z_2 s}{w_2} + 1\right)}$$

$$P(s) = \frac{0.5s^2 + 0.03s + 5.5}{0.1852s^3 + 0.2667s^2 + 25.01s + 1} e^{-0.02}$$

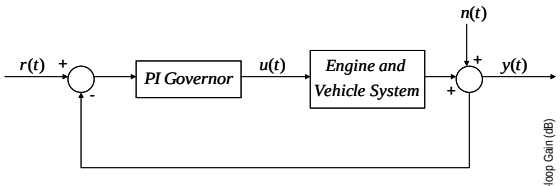
Closed-loop Identification on Experimental Data



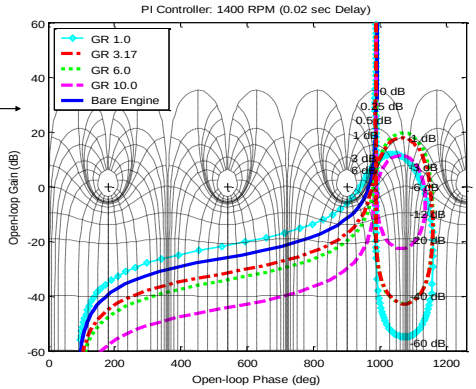


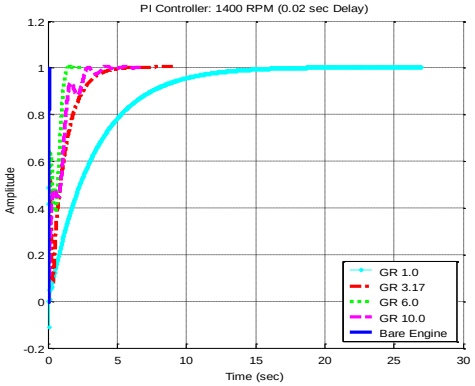
$$G(s) = \frac{\beta_0 s^3 + \beta_1 s^2 + \beta_2 s + \beta_3}{\alpha_0 s^3 + \alpha_1 s^2 + \alpha_2 s + \alpha_3}$$

Controller Architecture



Control objective is to maximize crossover frequency and minimize overshoot





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