Calculating all Filtered PI/PID Controllers Satisfying Gain, Phase and Sensitivity Specifications

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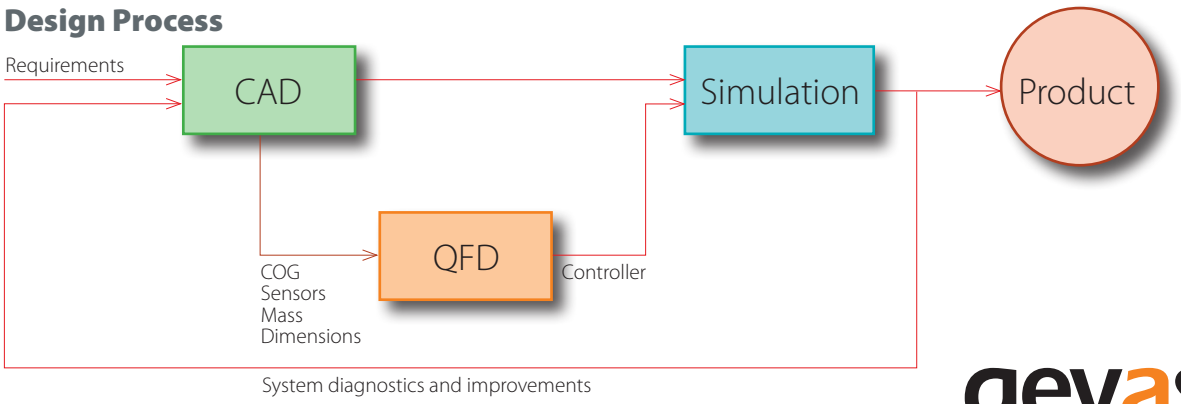
Abstract

The majority of industrial control architectures are filtered PI, PD, PID or cascaded with up to three sensors. Is it possible to design all relevant controllers that satisfy margin specifications without user intervention or experience? The answer is yes, and such an algorithm is presented here. The algorithm solves sets of linear equations with two unknowns and a single polynomial equation.

The result is a fully automated design sequence calculating all filtered PI/PD/PID controllers with an a priori chosen filter architecture that fits the industry needs, which are that a) the design specifies phase and gain margins, and bounds the sensitivity or complementary sensitivity function, b) it accounts for the exact amount of plant uncertainty (without over-estimating the uncertainty and the resulting over-design), c) it provides explicit equations to determine the set of all possible controllers, d) it can be applied to plants of any order, including ones with pure delay, unstable, and plants given by measured data, e) it allows for different sensor models for the P, I and D terms, f) it is possible to extend the method to account for sensitivity specifications that depend on the frequency, g) in using explicit equations, the algorithm is very fast, h) applying the algorithm does not require any control background to locate the optimal low-pass filter; extra conditions are required for the extension to PID and cascaded controllers.

Design Process



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