The Otto-Smith Predictor

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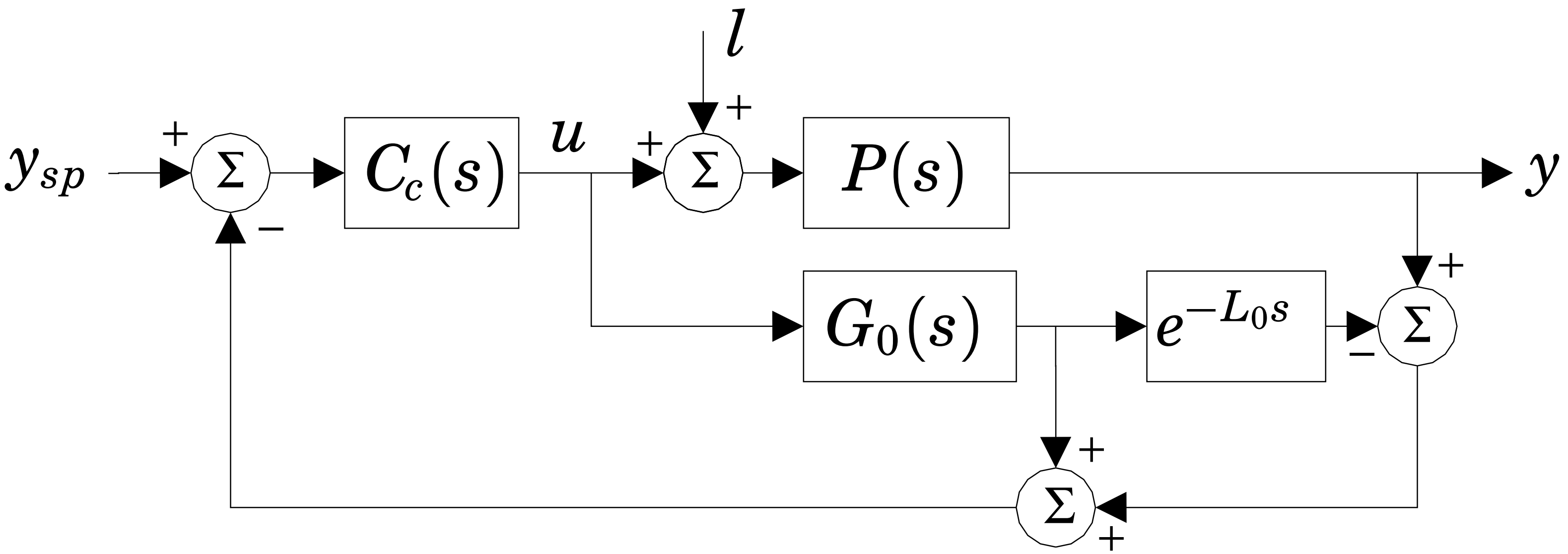
Overview

- Invented by Smith 1957
- Mainly used in process industry
- Mainly improves step responses
- Good for systems with long delays

Control Structure



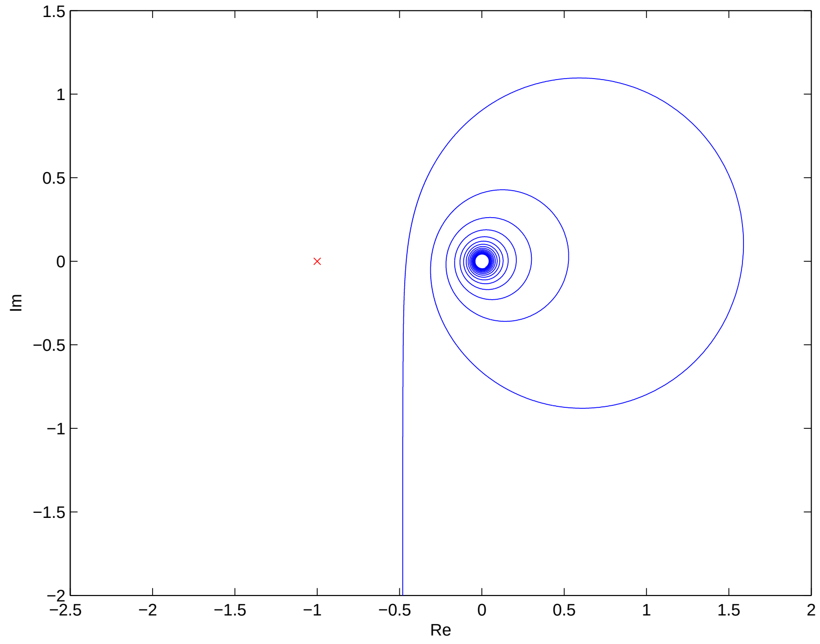
In this presentation the process $P(s)$ is a so called FOPDT, that is $P(s) = \frac{K_p}{Ts+1} e^{-Ls}$

C_c is typically is PI controller

Choosing $C_c = \frac{1}{T_r s} G_0^{-1}$ gives $T(s) = \frac{1}{1+T_r s} e^{-Ls}$ if $L = L_0$.

Robustness - Gain and Phase Margin

Nyquist plot of the loop transfer function with $T = T_0 = L = 1$ and $T_r = 0.24$.



It has been shown by Palmor and Blau that the real part is always greater than -1/2 and thus the gain and phase margin is at least 60° and 2 respectively.

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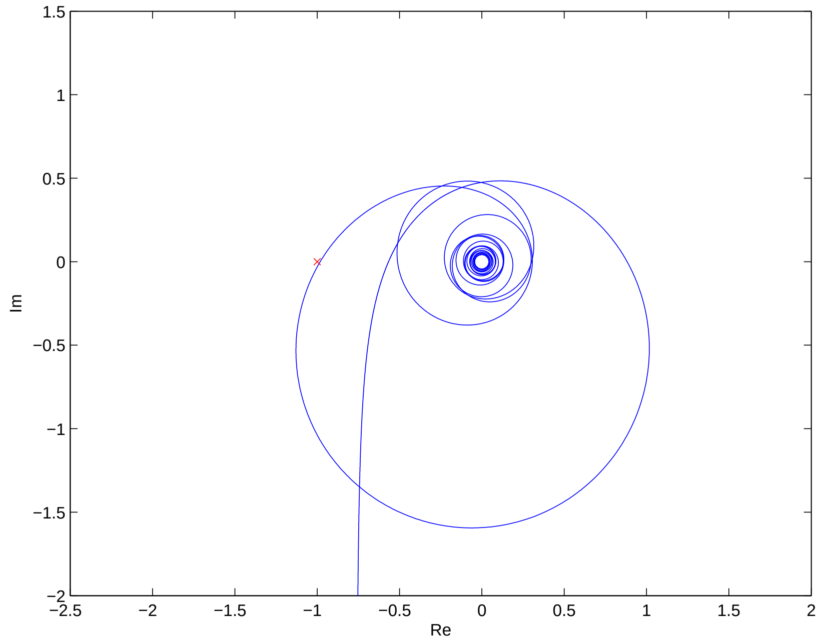
Robustness - Delay Margin

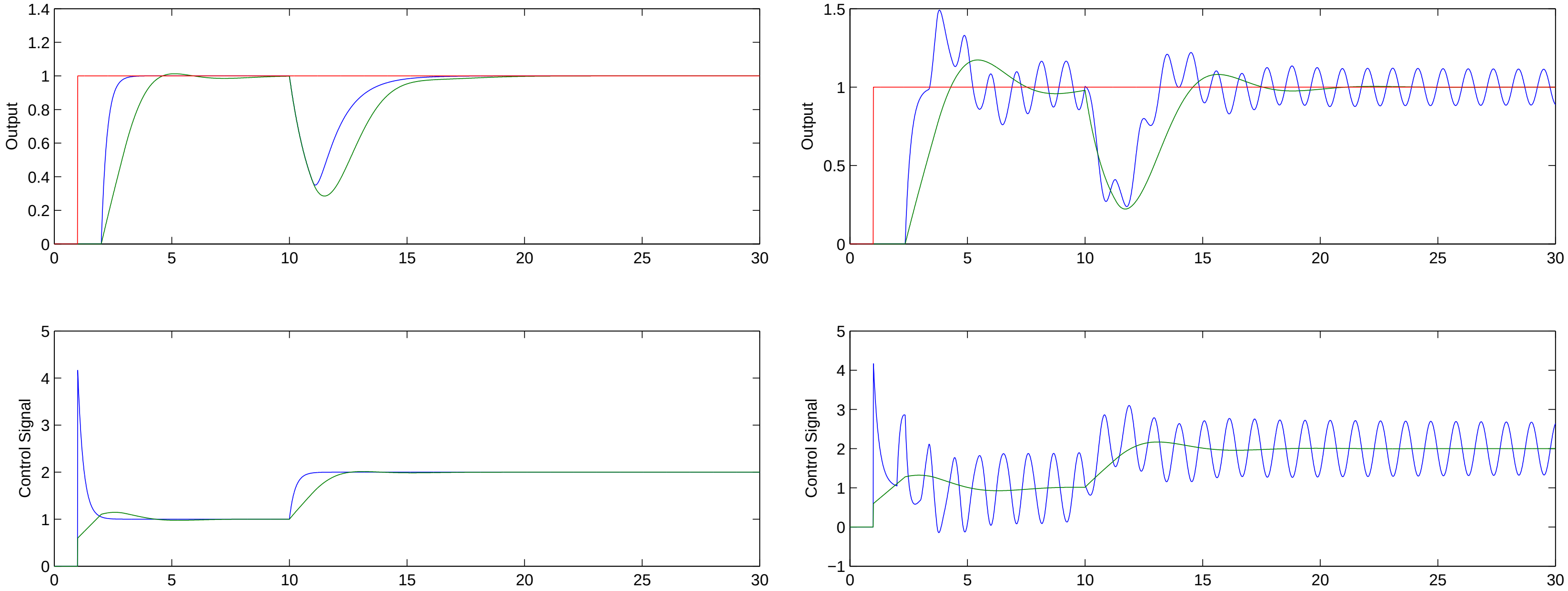
The same system as before but when the real delay is 35% longer than the one compensated for.



Palmor and Blau also showed that the Delay Margin depends on T_r/L_0 and some values are given below

D_M %	5	15	25	35	>100
T_r/T_0	0.03	0.10	0.16	0.24	0.34

Simulations



The green line is a manually tuned PI-controller, which seem to have a larger delay margin. The right plot shows the case when $L = 1.35L_0$.

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Pros and cons

+ Better performance
+ Easy to tune (but we need a model)
- More complex
- Harder to analyze