

1 Introduction

Laplace-Explorer was made for exploring the properties of control systems. In the first development stages, it was only meant for visualizing the root locus of a closed loop system. I found it hard to use a program like scilab or matlab for doing this. Later extensions have been time-domain- and frequency-response plots. All those views on one and the same system can be viewed at the same time. Parameter changes are actualized to all views immediately. The inversion of laplace back into the time domain is done numerically too. Two algorithms have been implemented so far. Gaver-Stehfest and Weeks's method. See:

<http://www.cs.hs-rm.de/~weber/lapinv/weeks/weeks.htm>

1.1 root locus

$$F(s) = \frac{num(s)}{den(s)}$$

The root locus of a closed loop system is extracted out of the characteristic equation.

$$den(s) = 0.$$

Laplace-Explorer solves this by using Newton's (Madsen) method. So the solution is a numerical one.

1.1.1 Simple Example

For example take the Plant as:

$$G(s) = 1/(s + 1)^3$$

And the controller as only proportional with gain k . So the open loop transfer function is:

$$G_o(s) = k/(s + 1)^3$$

By closing the loop we get:

$$G_c(s) = \frac{(k/(s+1)^3)}{(1+(k/(s+1)^3))}$$

Add the Expression into Laplace Explorer:

$$tf : (k / (s + 1)^3) / (1 + (k / (s + 1)^3))$$

Where tf: names the expression as tf. Then do a right-mouse click onto this expression and select in the pulldown-menu draw numeric root locus. A option dialog opens where you have to select a variable for parameter-sweep, the resolution and the range. By clicking Ok the Curve is added to the main-window and a independent slider is added. By moving the slider from zero to some value, one can observe the poles of the system moving toward the asymptotes. In the example above are 3 poles. 2 (one conjugate complex) poles cross the imaginary axis when the gain $k \geq 8$. This is the point where the System gets instable.

1.1.2 Extendet Example

For example take the Plant as:

$$G(s) = 1/(s + 1)^3$$

And the controller as proportional and integral with gain Kp and Ki:

$$G_c(s) = Kp + Ki/s$$

So the open loop transfer function is:

$$G_o(s) = (Kp + Ki/s)/(s + 1)^3$$

By closing the loop we get:

$$G_c(s) = \frac{((Kp+Ki/s)/(s+1)^3)}{(1+((Kp+Ki/s)/(s+1)^3))}$$

Add the Expression into Laplace Explorer:

$$tf : ((Kp+Ki/s)/(s+1)^3)/(1+((Kp+Ki/s)/(s+1)^3))$$

In the root locus options dialog select Kp as Variable for the sweep and click ok. Click onto the Variable Ki and select add slider in the pulldown menu. By varying Kp one can observe the roots moving on the path. By varying Ki, one can observe the changing paths of the loci.

1.2 Time domain response

Take one of the examples above and modify the transfer function by multiplying it with $1/s$ (step response).

$$S_r(s) = \frac{((Kp+Ki/s)/(s+1)^3)}{(1+((Kp+Ki/s)/(s+1)^3))} * 1/s$$

By right-mouse click onto this expression and selecting draw Response the response-options dialog opens. Select the complex variable s as variable and click Ok. A new window with the response opens.

1.3 Frequency response

Take one of the examples above.

$$S_r(s) = \frac{((Kp+Ki/s)/(s+1)^3)}{(1+((Kp+Ki/s)/(s+1)^3))}$$

By right-mouse click onto this expression and selecting draw Bode the bode-options dialog opens. Select the complex variable s as variable and click Ok. A new window with the response opens.