System parameters identification Scilab/Xcos

This tutorial displays a typical use case of optimization of control systems. The identification of parameters for a controller usually proceeds in the following steps:

1. Data acquisition of the system to regulate in open loop
2. Modeling the dynamic system
3. Identification of the system parameters
4. Set up of a control strategy (simple PID, to more evolve Model Predictive Control)

*Example* :

Second order system



Running a simulation with a unit step input (with the parameters K, Tau et Tau2 all equals 1):



Introduction of the block “to workspace” to gather the results of the simulation in the Scilab environment for post-processing:



Those results are then accessible through the variable *res*, contening 2 fields :

* values
* time



Next step: Write an optimization script running Xcos in batch to identify the 3 parameters of the second order system (K, Tau and Tau2).

Defining a cost function returning y, the distance between the simulated curve of the system and the unit step input function.

function **y**=cost\_for\_fminsearch(**x**)
 context = ["K="+string(**x**(1)) "tau="+string(**x**(2)) "tau2="+string(**x**(3))];

 *// On impose un cout infini si on sort de nos bornes de recherche.*
 if **x**(1) < 0 | **x**(2) < 0 | **x**(3) < 0 then
 **y**=%inf
 return
 end

 try
 *// Ouverture du diagramme => cree une variable scs\_m*
 importXcosDiagram(pwd()+"/Asserv\_2nd\_ordre.zcos");
 *// Changement du contexte*
 scs\_m.props.context = context;
 *// Simulation*
 xcos\_simulate(scs\_m, 4);
 catch
 disp("Error during xcos Simulation ...");
 error("cost function failed.")
 **y** = %inf;
 return
 end

 res\_ref = ones(40,1);
 **y** = norm(res.values - res\_ref)^2;
 e = get("costPolyline");

 e.data(:, 2) = res.values;
endfunction

The results are represented dynamically from this script iterating until finding the optimal solution in the defined interval:

f = gcf();
plot([0, 3.9], [1, 1], "r");
plot([0:0.1:3.9], zeros(40, 1));
e = gce();
e.children(1).tag = "costPolyline";
a = gca();
a.data\_bounds = [0, 0 ; 4, 1.8]

The optimization function called to identify the 3 systems parameters is [fminsearch](https://help.scilab.org/docs/6.0.2/en_US/fminsearch.html) :

opt = optimset( "Display" , "iter" );
[x fval] = fminsearch ( cost\_for\_fminsearch , [0 0 0] , opt );

The calling syntax of this function is:

* Cost function defining the quantity to minimize:
cost\_for\_fminsearch
* Starting point of the search:
[0 0 0]
* Advanced options with the function [optimset](https://help.scilab.org/docs/6.0.2/en_US/optimset.html):
options.Display = "iter" → the algorithm returns a message at each iteration

You can develop a Graphical User Interface (GUI) to modify manually the 3 parameters or trigger the automatic identification. When deployed on the Cloud, this application provides the interface on the right:

 