Sidra 2024 – Filippo Guarda

Homework on Data-Driven Systems

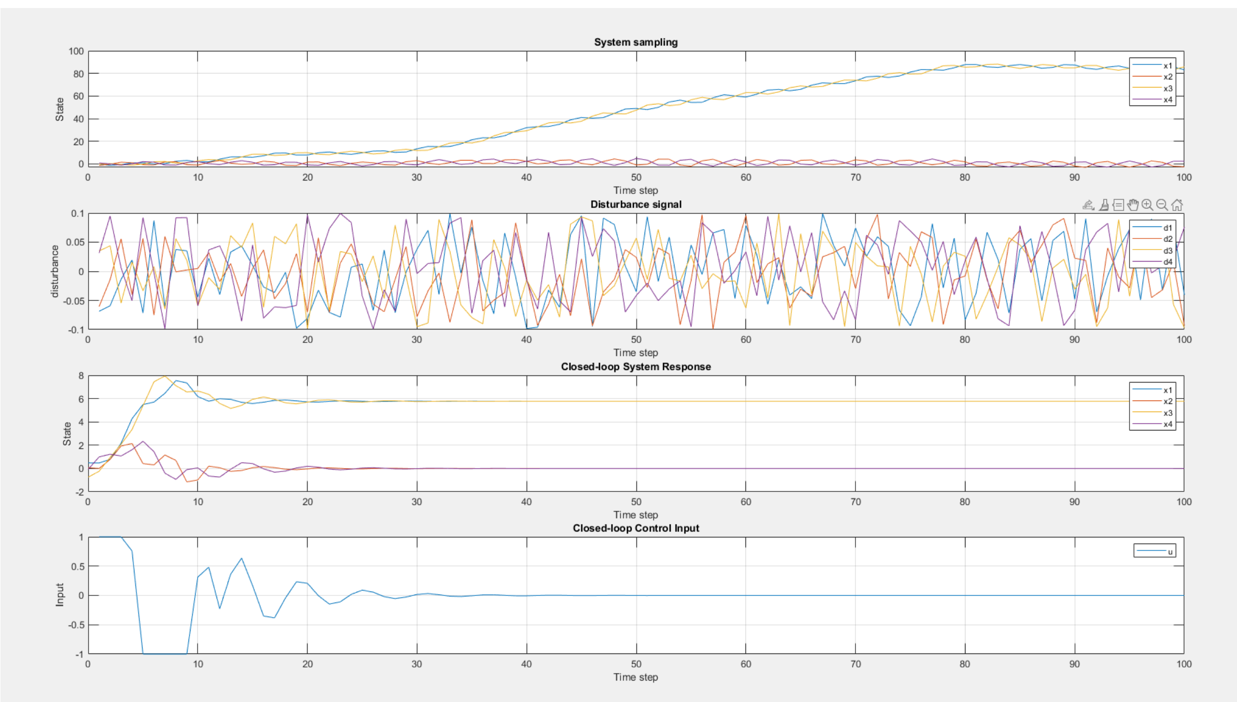
The problems selected for assignment 1 are P1 and P3, all the relevant Matlab code is available at:
https://github.com/FilippoGuarda/Sidra-2024---Data-Driven-Systems-Homeworks/tree/main

Assignment 1:

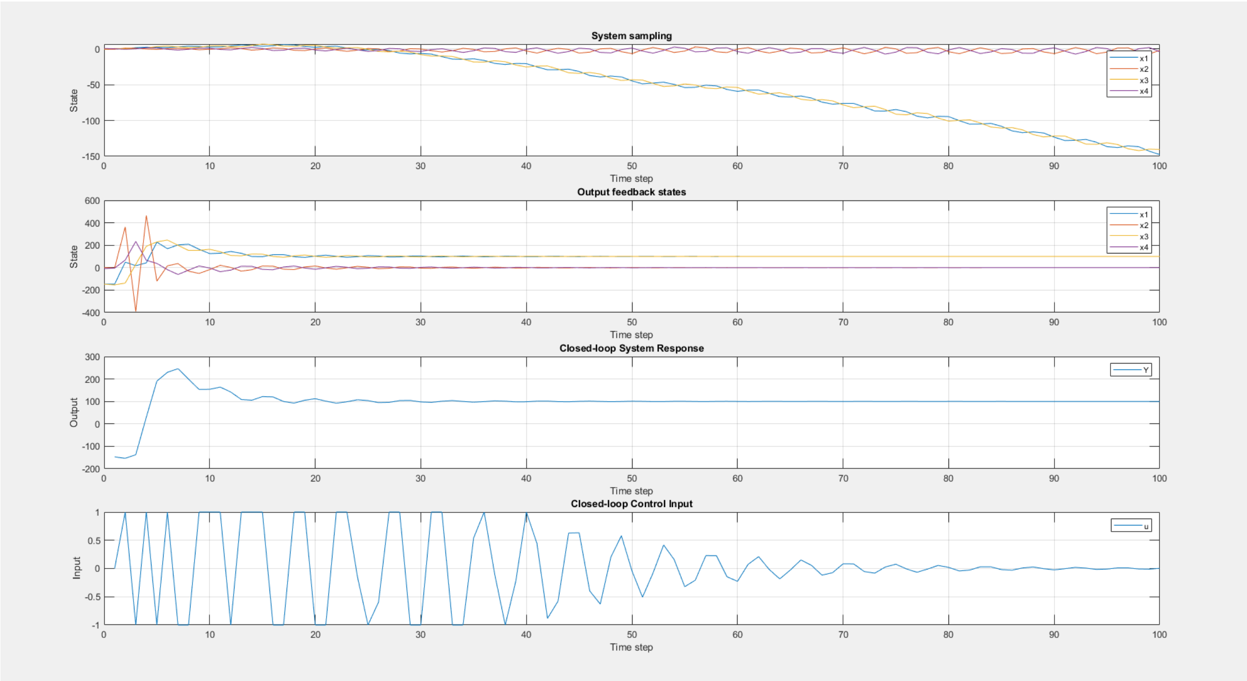
In both exercises P1 and P3, we first run a simulation with bounded random input and initial state, for P1 we also add a disturbance less than plus minus 0.1.

After obtaining U0, X1, X0 in P1 we solve for Y and S using cvx to obtain the gain K = U0*Y*S^(-1)
In the case of P3 we add a C matrix to extract y = X3 from the simulated state evolution. We build Phi from U and Y vectors.
As for P1, we solve for Q and P to obtain K = U0*Q*P^(-1) .
To account the impossibility of controlling both x1, x2 to zero in P1 and P3 a fixed value Xe was added to separate the two equilibrium positions while computing u.

Here are the results for P1, P3.
State Feedback:



Output Feedback:

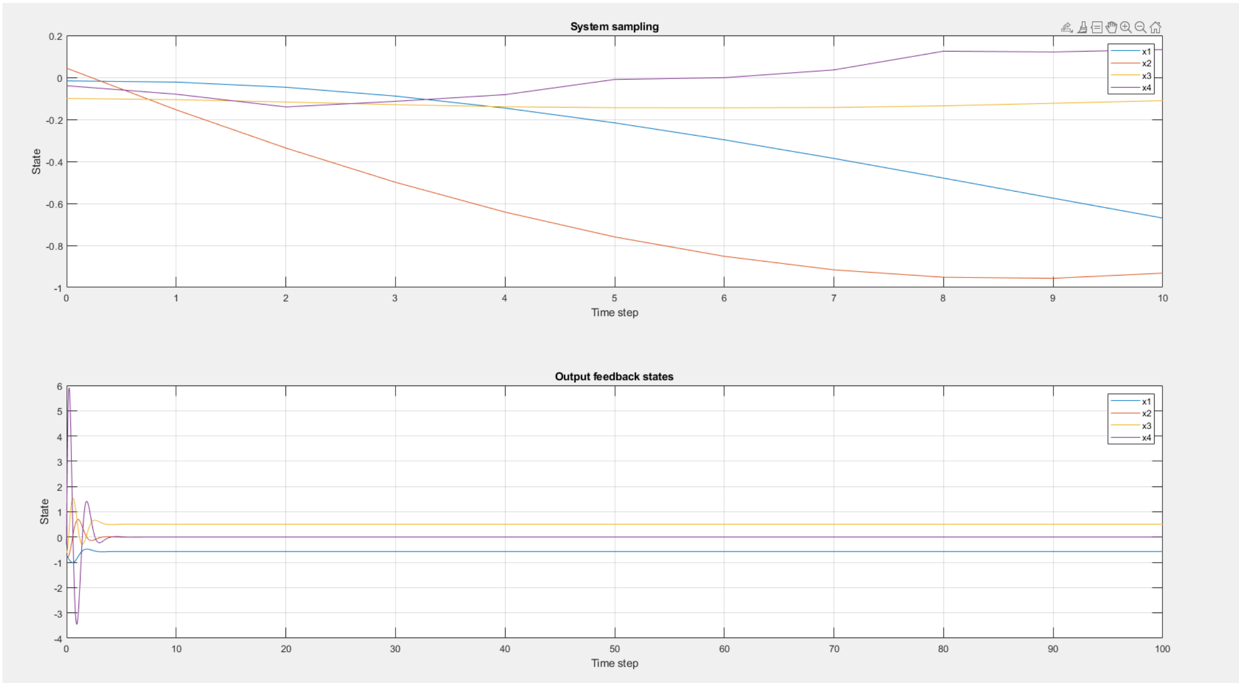


Assignment 2.

Similarly as what was done in assignment 1, we start by collecting the system state evolution from a random PE input signal, in this case though, we add an R matrix defined in such a way that it bounds all possible values of the nonlinear function Q = [sin(x) 0 0 0; …; 0 0 0 0].
For example, R = [1 0 0 0; …; 0 0 0 0] >= QQ^T for all values of x.
We also define a vector Z0 which contains the linear evolution of the states prepended to the nonlinear part of the function.
As before we use cvx to solve for P, Y, G2. We define G = [Y*P(-1) G2]. Finally, K = U0*G.

Fort the second example we take into account the regulation error with respect to a desired equilibrium setting the target at pi/3 like in the example and subsequently x5 = x1 – target.
The application of cvx is similar to previous times with the addition of the constraint M*[Y1 G2] = 0.

State feedback control of robot arm:



PI control of robot arm: