Simulation and Modeling of Dynamic Systems Task 2

On-line estimation of unknown parameters Slope Method-Lyapunov Method

The purpose of the laboratory exercise is the online estimation of unknown parameters with the gradient method and the Lyapunov method.

Topic 1

Consider the system:

$$\dot{x} = -ax + bu, \; x(0) = 0 \tag{1}$$

Where x is the state of the system, u is the input and a, b are fixed but unknown parameters that we want to estimate online.

a) Design a real-time estimator of the unknown parameters based on the gradient method and simulate its operation. Assume that the input to the system is u = 3. Plot x, $\hat{x}$ and the difference of these two, and the estimates $\hat{a}$, $\hat{b}$ of a, b respectively.

b) Design a real-time estimator of the unknown parameters based on the gradient method and simulate its operation. Consider the system input to be u = 3cos(2t). Plot x, $\hat{x}$ and the difference of these two, and the estimates $\hat{a}$, $\hat{b}$ of a, b respectively.

What differences do you notice between the two cases? Assume for your experiments that a = 1.5 and b = 2.

Topic 2

For system (1) and with input u = 3cos(2t) design a real-time estimator of the unknown parameters i) parallel structure, ii) mixed structure structure, based on the Lyapu nov method and simulate its operation when the state x of the system is measured with noise $\eta(t) = \eta_0 \sin(2\pi ft)$ with $\eta_0 = 0.25$ and f = 30. P $\hat{x}$ and the difference between these two, as well as the estimates $\hat{a}$, $\hat{b}$ of a, b respectively.

Compare the two methods. What do you notice as η_0 increases or the frequency f changes? Assume for your experiments that a = 1.5 and b = 2.