Mini-project for EE5104 Adaptive Control Systems, and EE6104 Adaptive Control Systems (Advanced)

In this CA3 mini-project, the methods of adaptive control with all state-variables measurable will be explored on an essentially fully equivalent and realistic software simulation.

Here, this is the first document (File01) describing the mini-project. It is essential that all the descriptions here are taken together with the companion second document (File02) for this mini-project.

1 Simulation of the L. J. Electronics d.c. motor apparatus

For the system to be controlled, the software simulation should first properly simulate the pilot-scale hardware platform, which comprises an L. J. Electronics d.c. motor apparatus (the Figure on Page 4 of the companion document File02) and a PC-based data-acquisition system with a graphical icon-driven software (File02 Page 5) which includes all necessary control system modular functions. For the d.c. motor apparatus, a nominal dynamic description based on appropriate experimental modeling is given in File02 Page 6.

For purposes only of simulation of the d.c. motor apparatus given in the Figure in File02 Page 6, it is stated here that this apparatus has the values of $K = 6.2 \;\; rad \;\; s^{-1}$ per $volt$, and $\tau = 0.25 \;\; seconds$. (Obviously this information above is only to allow you to properly and suitably realistically simulate the d.c. motor apparatus. These values clearly should not be used in your controller design computations.)

In addition, the simulation should incorporate the actual hardware situation that the input voltage $u(t)$ has the hard limits of $\pm 5 \;\; volts$.

2 Calibration of the d.c. motor sensors

The d.c. motor has angular position (potentiometer) and angular velocity (tachometer) sensors. In order to be able use these for implementing a control system for the d.c. motor, the voltage outputs of the sensors need to be related (calibrated) to the actual angular position and angular velocity measurements.

Here, in the associated companion file, all the required calibration data have already been collected. The information from all these calibration data should be incorporated into your simulations. (Thus you should certainly carefully read, and understand all the information pertaining to the real-world hardware as described in File02.)

3 Adaptive control with all state-variables measurable

In the investigations in this section, the stated measurements available on the given apparatus may be used.

3.1 Adaptive control with all state-variables measurable

After you have fully set up the simulation for the d.c. motor apparatus, note that just as in the real-world hardware situation, the only signals available to you are (a) $X_1(t)$ which is the Potentiometer Output (in *volts*); and (b) $X_2(t)$ which is the Tachogenerator Output (in *volts*). (You can ignore the remarks at the bottom of File02 Page 6, on gear-ratio etc as they are for information only and not relevant to this mini-project.)

Using MATLAB/Simulink (or any other programming language that you prefer), set up a suitable adaptive controller for this situation (which is essentially a situation of Adaptive control with all state-variables measurable).

Note that in emulating essentially the real-world situation of the d.c. motor apparatus, the computed control signal $u(t)$ of your adaptive controller design will be a voltage signal (i.e. in *volts*).

For the mini-project, investigate all pertinent matters (such as various choices of the appropriate reference model state matrix $\mathrm{A}_{\mathbf{m}}$; various different reference command signal $r(t)$; effect of different choices of the design parameters; effect of possible realistic noise in the measurements, etc.)

Document, describe, analyze in as much detail as desired all your investigations.

Being a simulation mini-project, in many ways, the possible further investigations can also be open-ended with your own choices for further investigations. Thus, also document, describe, analyze in as much detail as desired all your further investigations.

3.2 Further requirements for EE6104

In addition to all the above, with the same realistic software simulation, further set up, and investigate the adaptive control of the angular velocity of the d.c. motor apparatus. Document, describe, analyze in as much detail as desired all your investigations.

Additionally, further design an adaptive control of the angular velocity of the d.c. motor apparatus, by incorporating integral (or integrating) action as an additional component in the computed control signal $u(t)$. Document, describe, analyze in as much detail as desired all your investigations.