Nonlinear Control (FRTN05)

Computer Exercise 1

Last updated: Spring of 2008

Consider the nonlinear system

$$\dot{x} = -x + x^3 + u \tag{1}$$

1. Build a simulation model in Simulink for system (1). Simulate it for different initial conditions $x(t = 0)$ when you don't use any control ($u = 0$). Determine via simulation in which region of initial values $x(0)$ the solutions $x(t) \to 0$ as $t \to \infty$.
2. Which are the equilibrium points of the system if $u = 0$? What equilibrium points are there if $u = 1$?[1]
3. Sketch a diagram of the x-axis and the corresponding directions of $\frac{dx}{dt}$ when $u = 0$. what does it show of the local stability properties of the equilibrium points found in (2)?
4. Suggest a feedback control law $u = u(x)$ which makes the origin $x = 0$ a globally stable equilibrium point.
5. Assume now that you have bounded control action, $u \in [-10, 10]$. Try your controller from (4) realized as $u = sat_{10}(\dots)$, that is, you have a saturation at ± 10 after your control law from (4). What is the largest range of stability? Simulate and compare with your analysis.

[1] You may use the Matlab command `roots`.