Robust and nonlinear control EEN050

Assignment 5

Nonlinear control system analysis

Before submission pre-approval of solution is mandatory

Problem formulation and aim

Consider the problem of nonlinear stabilization and tracking of SISO systems. Analyze and numerically solve these type of problems (with Matlab or alike).

Administration

- The assignment is solved in a group of three students, documented in an electronic solution report (plots, explanation, reply to questions).
- Pre-approval of solution by TAs is mandatory before submission (during tutorial sessions)
- Electronic submission to CANVAS, upload 1 solution per group using the filename: Group#-Assignment#.pdf after getting a preliminary oral approval from the TA (tutorial session).
- Results, no later than 1 week after submission (with constructive feedback). If the solution is not approved, a single week time is given for correction (one extra chance only).
- Deadline: check the course PM.

Questions

Given a reaction-diffusion model

$$\dot{x}_1(t) = 2(x_2(t) - x_1(t)) + x_1(t)(1 - x_1^2(t))$$
$$\dot{x}_2(t) = -2(x_2(t) - x_1(t)) + x_2(t)(1 - x_2^2(t))$$

Exercise 1 Find all equilibria. What kind of equilibria are/is those/that?

Exercise 2 Plot the phase portrait for the underlying system [1]. Based on the phase portrait what can you conclude on global asymptotic stablity?

Exercise 3 Does it have limit cycles (closed limit cycles)?

Before submission pre-approval of solution is mandatory

References

[1] BL Stevens and FL Lewis and N Johnson *Aircraft Control and Simulation*. John Wiley and Sons Ltd, 1989.

[2] JG Balchen, NA Jenssen, E Mathisen, and S Saelid *A dynamic positioning system based on Kalman fitering and optimal control.*. Modeling and Identification and Control vol 1, pp 135-163, 1980.

[3] OM Faltinsen *Sea Loads on Ships and Offshore Structures*. John Wiley and Sons Ltd, 1994.

[4] E A Johannessen *Dynamic Positioning of Surface Vessel*. 1996.

[5] S. Skogestad, I. Postletwaite *Multivariable feedback control: analysis and design*. Wiley, New York, 2nd edition, 2001

[6] HK Khalil *Nonlinear Systems*. Prentice Hall, Upper Saddle River, NJ, 1996

[1] `http://matlab.cheme.cmu.edu/2011/08/09/phase-portraits-of-a-system-of-odes/`