EE 407

Homework 2

Due 23:55, 9.11.2018

1 Prerequisites

Before proceeding to the questions please make sure that you've already fulfilled the following items.

- Feel confident with the general procedure of Git version control. If you have any hesitation, go through at least one of the numerous online sources, i.e., [1], [2], [3].
- Open a GitHub account using your metu email. Then get the Github student pack, [4]. (Both of the partners should individually open GitHub accounts.)
- One of the partners should accept the invitation of this assignment via below link and *create a new team*. It will give you access to a repository, namely *ee-407-hw2-2018-YourGroupName*, in the @METU-EE407 organization on GitHub. Then, the other partner clicks the same below link and joins the corresponding team. After these steps, both partners will be able to work on the same repository while we are keeping a kind eye on your project.
  `https://classroom.github.com/g/yCxU5jjw`
- We expect each member of a team to make <u>at least</u> one commit to the repository.
- Don't forget to put your names and student IDs in a README file in your repository.

2 Questions

1. **Water Reservoir System**

   Consider the water reservoir system, illustrated in Fig. 1, which is desired to supply water to a city. The reservoir is fed by the streams q_1, q_2 and q_3 where $q_i = q_1 + q_2 + q_3$ given in units of $m^3/hour$. The outlet water flow, q_o $(m^3/hour)$, is controlled in such a way that the flow to the city is rendered proportional to the quantity of water in the reservoir, w (m^3). Proportionality constant is $K = q_{o\gamma}/w_\gamma$ where $q_{o\gamma} = q_{o,max} - q_{o,min}$ and $w_\gamma = w_{max} - w_{min}$.

   (a) Find the relationship between q_o and q_i.

   (b) Find and plot q_o when q_i is a unit step and initial conditions are zero.

   (c) Find w_γ, the difference between specified maximum and minimum storage of water (m^3), such that we do not have to drain water via the bypass pipe before 5 days if a sudden rise of magnitude $B \times K \times w_{max}$ $(m^3/hour)$ in q_i occurs due to excessive rainfall $(w_{initial} = w_{min})$.

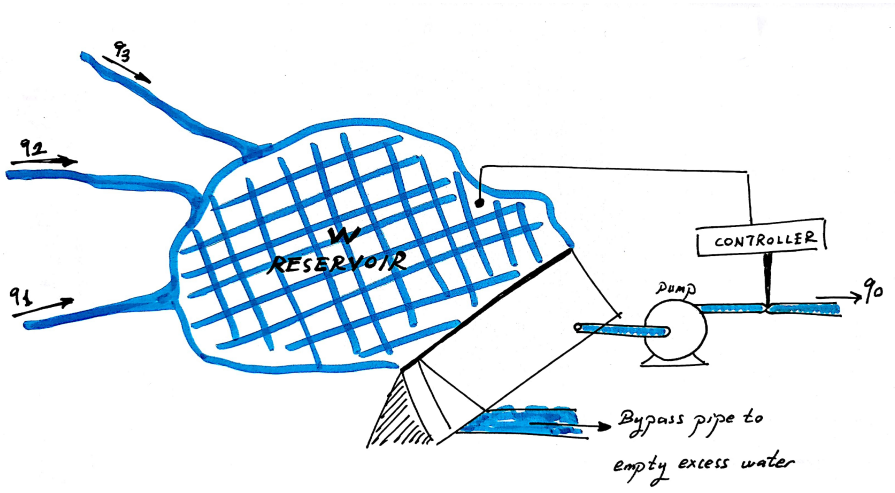

Figure 1: Schematic of the Reservoir System

2. An Ecological System

You have already been introduced with ecological system modeling during lectures. In this question, you are basically going to simulate a prey-predator system under different assumptions.

(a) Create a new Simulink file under your Simulink project and name it as *Question2*. In this model, you are required realize the following set of equations.

$$\dot{y_1} = (1 - y_2/\eta_2)\, y_1 \tag{1}$$

$$\dot{y_2} = -(1 - y_1/\eta_1)\, y_2 \tag{2}$$

Notice that y_1 and y_2 stand for the number of prey and predator species, respectively. Besides, η_1 and η_2 are constants determining the relation between two populations.

(b) Simulate the model for the following set of parameters. In your report, include a figure exhibiting y_1 and y_2 over time. The figure should have a title, labeled axes, and reasonable axis limits.
($\eta_1 = 300,\ \eta_2 = 200,\ y_{1,initial} = 400,\ y_{2,initial} = 100$)

(c) Comment on the pattern of populations. Is there anything remarkable about observed responses? Can you give an example of a nonlinear system having similar properties?

(d) Commit the current version of the model with a plausible commit message and push the local repo to the remote repository on GitHub.

(e) Find the nonzero equilibrium point of the system, i.e., ($y_{1,initial} \neq 0, y_{2,initial} \neq 0$). When the initial value of populations is close to the equilibrium point, how does the period and characteristics of the oscillations change?

(f) In this step, modify the model according the equations given below. Note that the modification is to introduce a growth limiting term for the prey population.

$$\dot{y_1} = \left(1 - \frac{y_1}{2 * y_{1,initial}}\right)(1 - y_2/\eta_2)y_1 \quad (3)$$

$$\dot{y_2} = -(1 - y_1/\eta_1)y_2 \quad (4)$$

(g) Simulate the model with the previous parameter set. In your report, include a figure exhibiting y_1 and y_2 over time. The figure should have a title, labeled axes, and reasonable axis limits. Comment on the shape of the solution curves? Are they still periodic, if so how does the length of a period change?

(h) Commit this version of the model and push it to the remote repository on GitHub.

3. We will evaluate your response considering the files included in your GitHub repository. Therefore, please add your *Report* in .pdf format to the remote repository.

References

[1] "OKST by Ozan Keysan," http://keysan.me/okst/, accessed: 01.11.2018.

[2] "Git Baslangic by Ali Ozgur," `https://aliozgur.gitbooks.io/git101/content/bolum_1_-_baslangic/versiyon__kontrolu_nedir.html`, accessed: 01.11.2018.

[3] "What is Version Control?" https://www.atlassian.com/git/tutorials/what-is-version-control, accessed: 01.11.2018.

[4] "GitHub Student Developer Pack," https://education.github.com/, accessed: 01.11.2018.