Report Bart

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Summary

Goal

The Goal for this report is:

- Make a planning
- Literature study on system identification/modelling and validation
- literature study on controller design

Problems

It is a bit unclear to me which valves we can control.

Planning

The planning has been made in an excel sheet and can be adjusted according to our progress. I copied the important dates of the planning and the learning objectives from the study guide. I think it is best if we structure our planning according to the learning objectives and for now I think the preliminary report in which the approach will be explained is more important than detailed modelling. Additionally the corresponding calendar items have been made. However maybe the tubes are short and this additional friction loss can be neglected.

Modelling/system identification

tubes and valves

With all the (ball) it is evident that the system is nonlinear. Though still still means that the system can be piece-wise linear within its tubes. The pressure loss in the tubes can be estimated with fluid flow equations and with an estimated tube diameter of 2cm, 3cm the 4cm(as the dimensions are unknown) with maximum flow rate of 0.1L/sec the system is definitely nonlinear at high fluid flows and therefore the tubes are also nonlinear.

Pump(s)

The setup was also found on a website `http://www.gurski.biz/Start/index.htm` and when one looks at the TS21 Tank-System section one can observe that there is an diaphragm pump, which looks similar to the test setup to be tested by us and has a similar test max flow rate. The pump characteristics of such a pump are illustrated in figure 0.1 and one can observe that the relation between the pressure and flow rate is not linear. Furthermore the pump efficiency is dependent on flow rate. So it is evident that the pump will not be linear, unless we select 1 operating points.

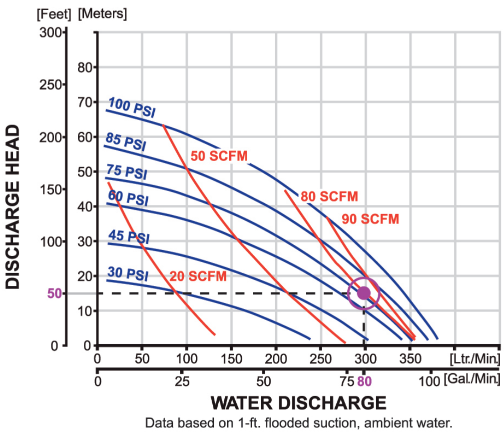

Figure 0.1: likely to be observed pump characteristics

0.1 Literature study

- `https://hal.archives-ouvertes.fr/hal-00977494/document` This study shows a first principle model and mentions that the system is nonlinear as multiple submodels describe the whole model
- `https://www.researchgate.net/publication/3052905_Development_of_a_Web-Based_Control_Laboratory_for_Automation_Technicians_The_Three-Tank_System` another sutdy shows the identified model with equations

- `http://naun.org/main/NAUN/ijmmas/17-869.pdf` this paper shows also that the valves have a nonlinear model

UPDATE: the system is the Three Tank System DTS200

I found a manual online and I think this is the setup. `https://www.shiva.pub.ro/PDF/Diagnoza/Documentatie_standul_3_rezervoare.pdf` It indeed shows that there is a diaphragm pump. It also mentions that the nonlinear system can be decoupled into linear systems.

control

As it is clear that our setup is non linear, but may be piecewise nonlinear, nonlinear as well as linear controllers are possible.

Nonlinear control

- I don't know much about this, but something like input-output linearisation might be suitable. I do much prefer the linear control as that is one of my strengths. I saw in papers that nonlinear control has been applied to the three tanks system.

linear control

- Model predictive control is possible and maybe necessary because we have input constraints `https://sci-hub.tw/https://doi.org/10.1016/j.camwa.2013.01.021`
- MPC with an LPV statespace could also be done.
- A simple P(I)D controller is also possible, but it may be difficult to tune as we have constraints on the input
- A (Luenberg) observer is definitely needed