Model Predictive Control of a Sewer System

June 14, 2018

Group 1030

Jacob Naundrup Pedersen
Thomas Holm Pilgaard

Department of Electronic Systems
Aalborg University
Denmark

AALBORG UNIVERSITY
DENMARK

Agenda

Introduction

Implementation

Control

Results

Discussion

Conclusion

Introduction

- slide 1 hello world

Overview

Jacob Naundrup Pedersen

- Implementation
- Control
- Results
- Discussion
- Conclusion

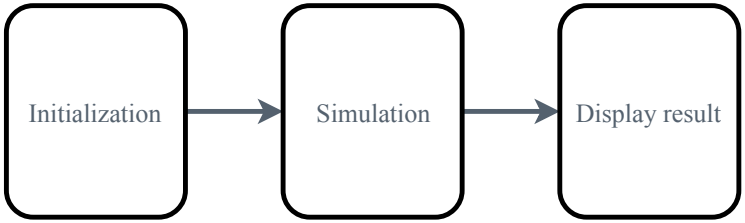


Figure: Chosen structure of simulation environment.

1. Pipe
   - Length [m]
   - Sections (Number of sections the pipe should be split in to)
   - S_b (Slope) [‰]
   - Δx = Length/Sections [m]
   - Diameter [meter]
   - Theta (parameter used in Preissmann scheme)
   - $Q_f [m^3/s]$
   - Side/lateral inflow present
   - Section location in data
2. Tank
   - Size $[m^3]$
   - Height [m]
   - Area = Size / Height $[m^2]$
   - Maximum outflow $[m^3/s]$
   - Section location in data

Table: List of parameters for pipe and tank.

Fields	length	sections	Dx	Sb	d	Theta	Qf	side_inflow	data_location
1	700	35	20	0.0030	0.9000	0.6500	0.9730	0	1
2	303	15	20.2000	0.0030	0.9000	0.6500	0.9730	0	3
3	27	2	13.5000	0.0030	1	0.6500	1.2843	1	4
4	155	8	19.3750	0.0041	1	0.6500	1.5014	0	5
5	295	14	21.0714	0.0122	0.8000	0.6500	1.4386	0	6
6	318	15	21.2000	0.0053	0.9000	0.6500	1.2932	1	7
7	110	5	22	0.0036	0.9000	0.6500	1.0658	1	8
8	38	2	19	0.0024	1	0.6500	1.1487	1	9
9	665	30	22.1667	0.0030	1	0.6500	1.2843	1	10
10	155	7	22.1429	8.0000e-04	1	0.6500	0.6632	0	11
11	955	47	20.3191	0.0029	1.2000	0.6500	2.0415	1	12
12	304	15	20.2667	0.0030	1.2000	0.6500	2.0764	0	13
13	116	5	23.2000	0.0021	1.2000	0.6500	1.7373	1	14
14	283	12	23.5833	0.0017	1.4000	0.6500	2.3463	1	15
15	31	2	15.5000	0.0019	1.4000	0.6500	2.4805	1	16
16	125	6	20.8333	0.0021	1.6000	0.6500	3.7075	0	17
17	94	4	23.5000	0.0013	1.5000	0.6500	2.4609	0	18
18	360	18	20	0.0046	1.6000	0.6500	5.4872	1	19
19	736	38	19.3684	0.0012	1.6000	0.6500	2.8026	0	20

Figure: Setup in MATLAB of pipe specification of the main line in Fredericia.

Field	Value
size	90
height	10
area	9
Q_out_max	0.9730
data_location	2

Figure: Setup in MATLAB of tank specifications.

Fields	type	component	sections
1	'Pipe'	1	35
2	'Tank'	1	1
3	'Pipe'	18	245
4	'Total'	20	281

Figure: Display of structure showing system setup information in MATLAB.

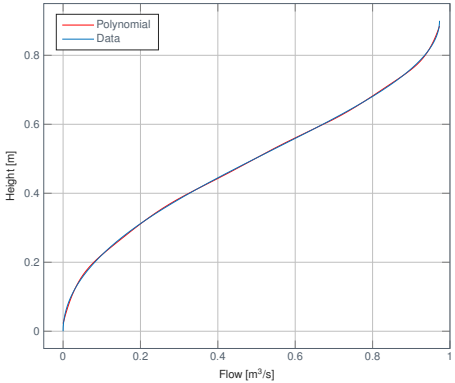


Figure: Comparison between data obtained by equation **??** and the same data curve fitted to a ninth order polynomial.

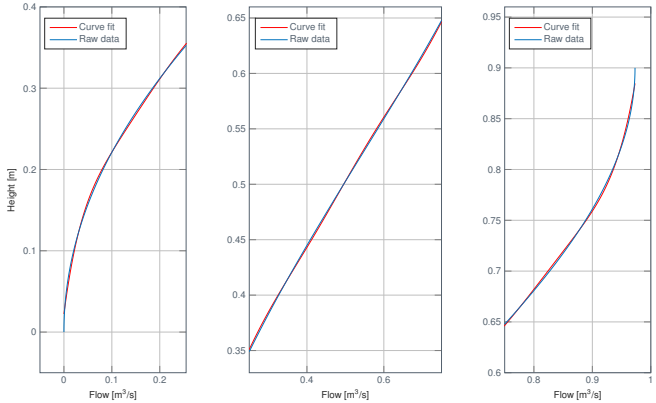


Figure: Comparison between data obtained by equation **??** and the same data curve fitted to a ninth order polynomial.

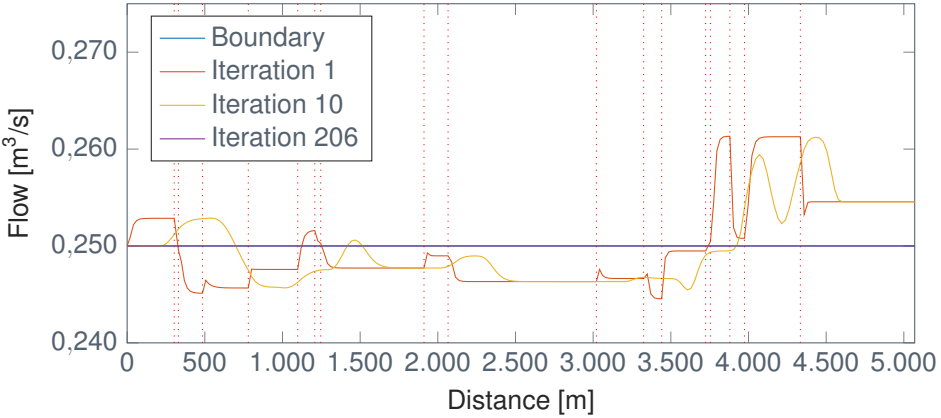


Figure: Height and flow of pipe setup from part of Fredericia where boundary conditions is found by fitted polynomial. Various amount of iterations, with constant flow input of 0,25 m^3/s, is performed. The dotted line indicates pipe intersections.

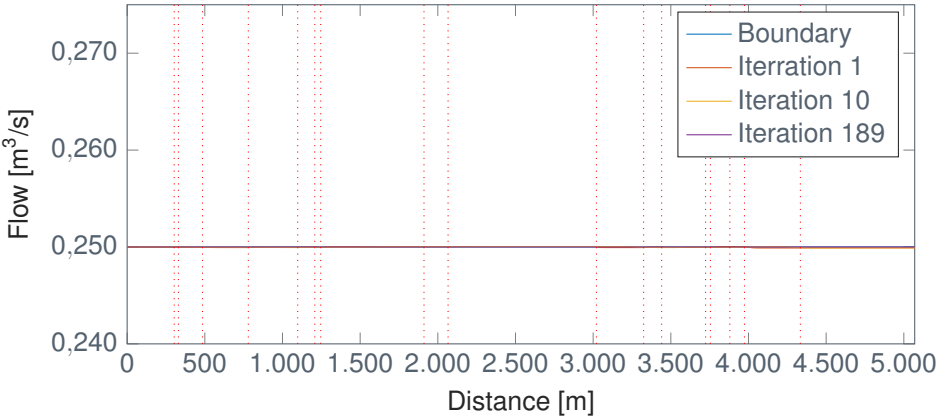
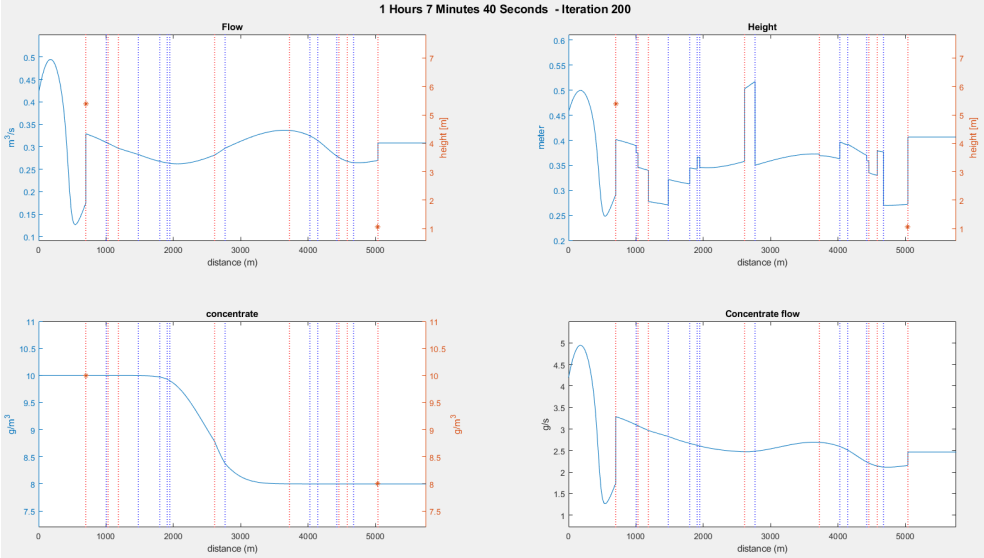


Figure: Height and flow of pipe setup from part of Fredericia where boundary conditions is found by lookup table. Various amount of iterations, with constant flow input of 0,25 m^3/s, is performed. The dotted line indicates pipe intersections.

- Preissmann scheme



Figure

Dept. of Electronic Systems
Aalborg University
Denmark

- Sinus
- Flow profiles

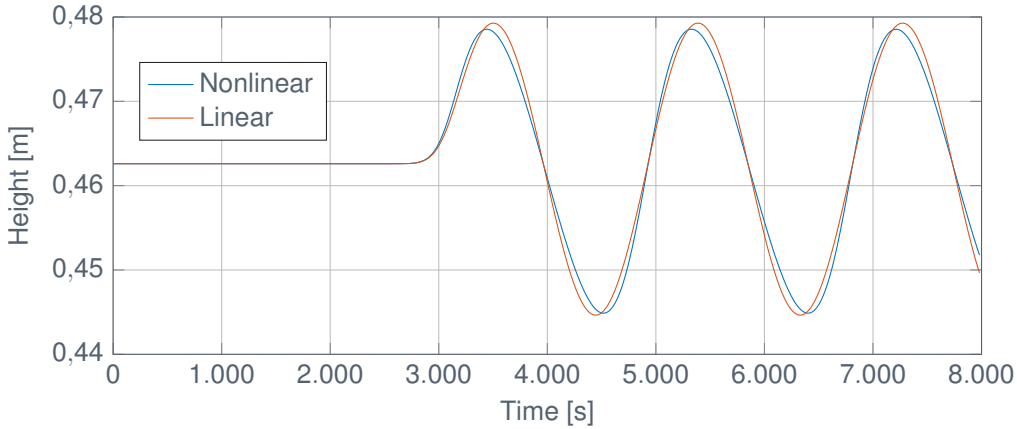


Figure: Comparison of the nonlinear and linear model at the last pipe in the setup.

- Cost function
- Constraints
- Linear model

- Bestemmelse af Prediction horizon
  - Flow profiler
  - Industri
- Begrænsning af Prediction horizon

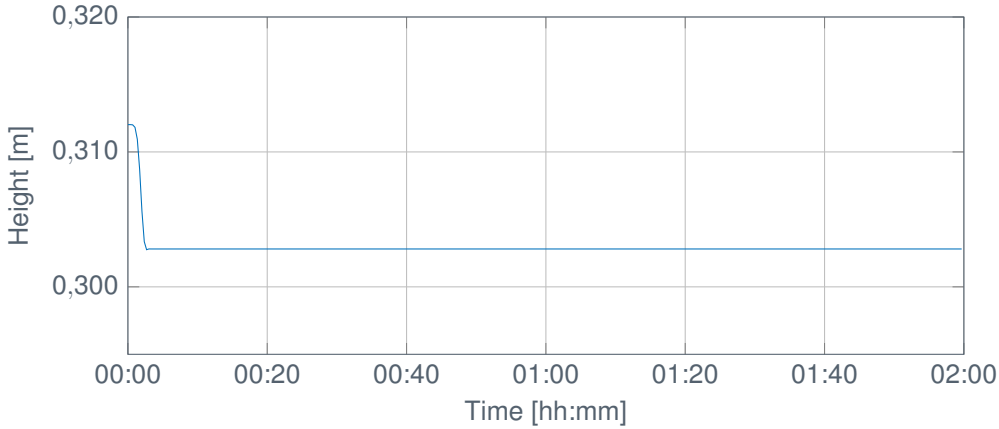


Figure: Output of the last pipe.

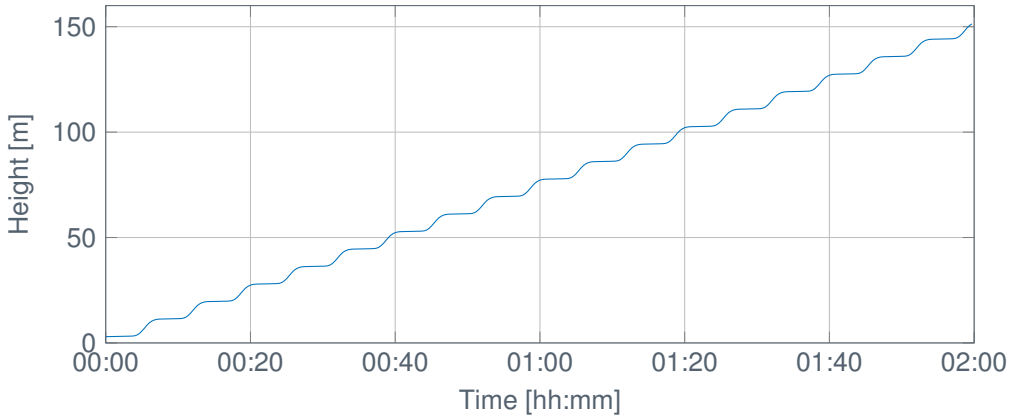


Figure: Height in the tank.

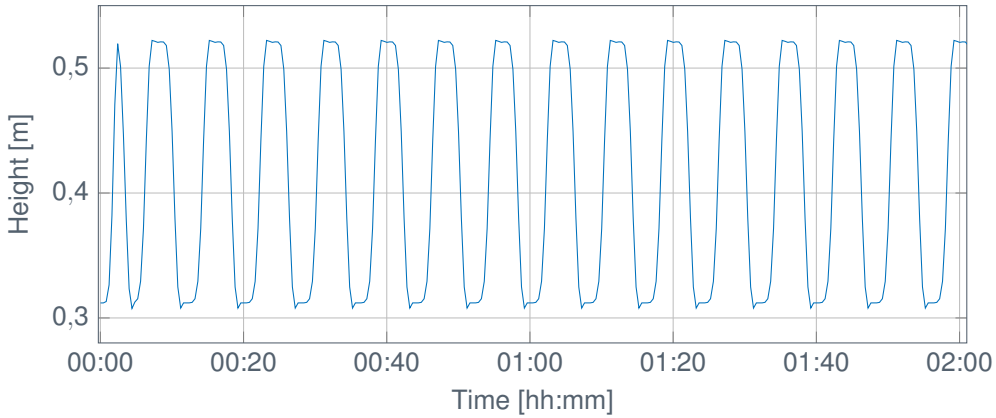


Figure: Output of the last pipe in the second simulation run.

- System setup
- Flow profiles

Type	Component	Sections
Pipe	1	35
Tank	1	1
Pipe	17	207
Tank	1	1
Pipe	1	38
Total	21	282

Table: System setup.

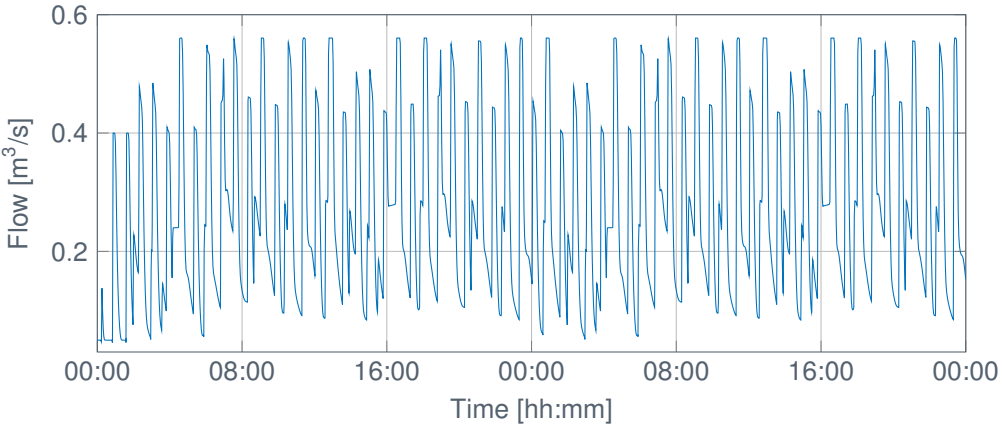


Figure: Output of the last pipe into the WWTP.

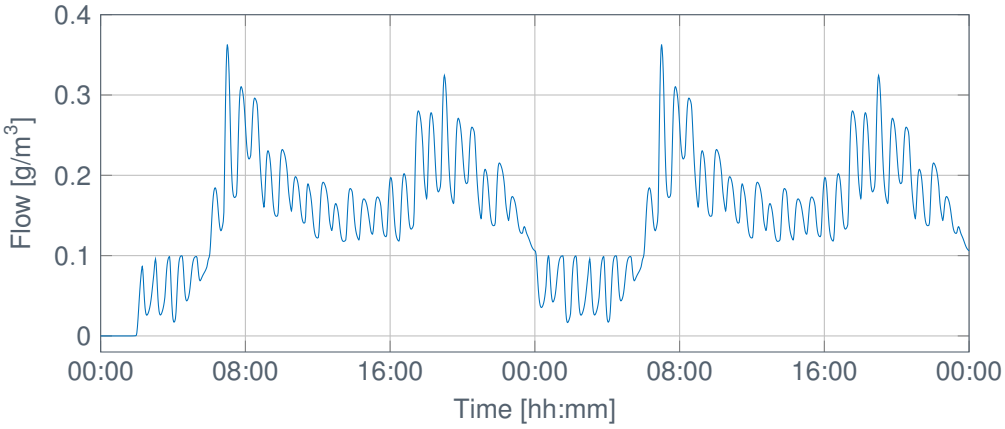


Figure: Simulation of COD output of the last pipe into the WWTP.

- Over dimensioneret tank
- Konstant output af tank

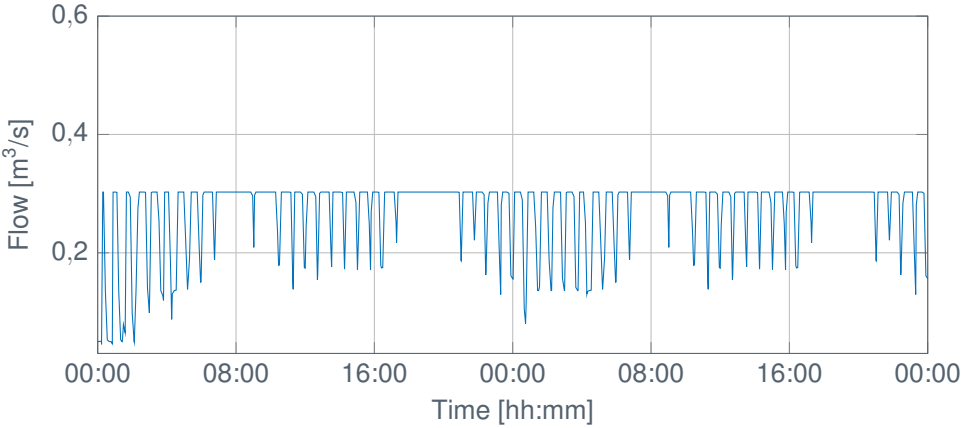


Figure: Output of the last pipe in to the WWTP, where a tank has been placed in front to reduce variation in flow into WWTP.

Discussion

- Courant's number
- Model reduction

Conclusion

- Simulation
- MPC