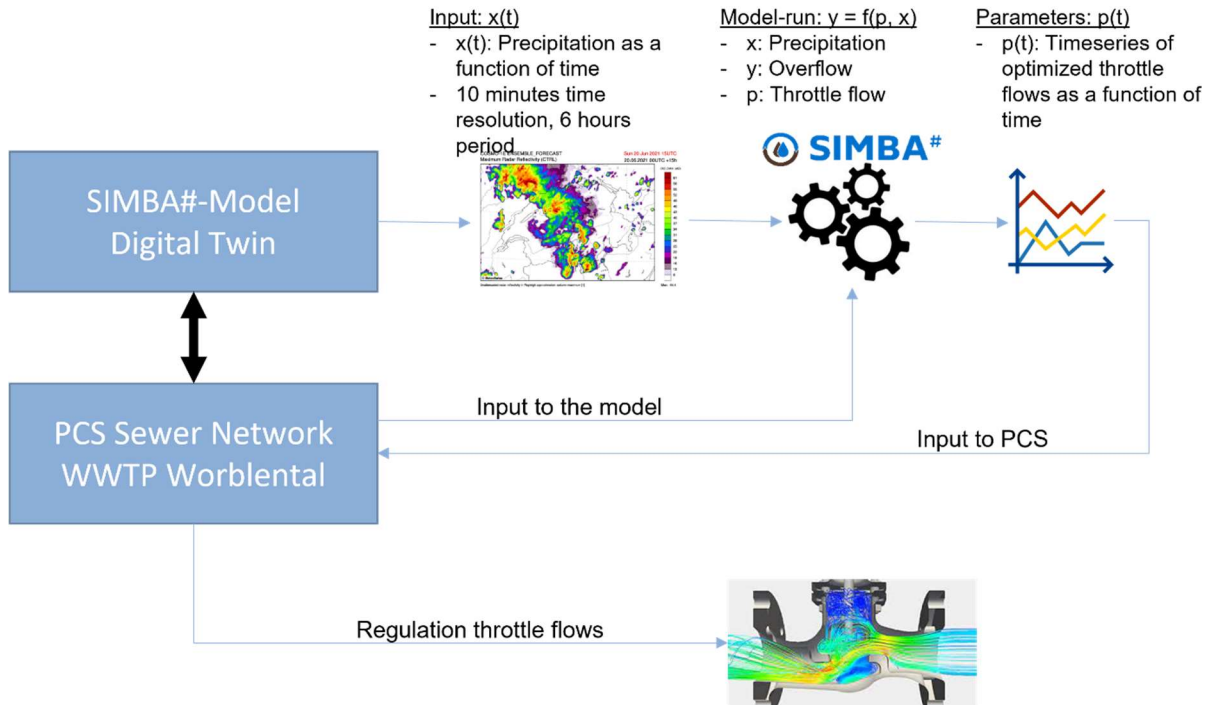


Worblental: Digital Twin of Wastewater Network

Keywords: data analysis, programming, precipitation prediction, timeseries analysis, computer modeling

Proposed: December 2022

Valid until: January 2024



Background:

The urban catchment of the wastewater treatment plant Worblental (WWTP Worblental) encompasses the municipalities of Zollikofen, Ittigen, Bolligen, Ostermundigen, Stettlen, Vechigen, Worb, Biglen, Arni, as well as subareas of Grosshöchstetten and Münsingen. In 2018 the WWTP Worblental took over various stormwater overflows and a big share of the main sewer of the urban catchment (39 km as against the previous 13 km). As of today, the WWTP Worblental urban catchment comprises 8 stormwater tanks and numerous stormwater overflows. All the stormwater tanks are connected to the process control system (PCS) provided by Chestonag Automation AG and the throttle flows were statically optimized within the regional general wastewater management plan (VGEP).

The WWTP Worblental has a vision to create a digital twin (SIMBA[#]-Model) of the whole catchment which computes the ideal system settings based on precipitation forecasts and which applies those settings to the real system in real-time.

The current SIMBA[#] Model was connected to the PCS in December 2022: the model runs parallel to the real system, in real-time with precipitation forecast data and saves inputs and outputs at every loop. The objective is to compare the results generated by the model with the data measured by the sensors in the real system. As input to the model, radar precipitation forecast data are used. New precipitation forecast data, spanning over a time-period of 6 hours are

available every 10 minutes. The model reads real-time data from the PCS, such as the water level in the stormwater tanks, and sets those as initial conditions for the next simulation.

Objectives of the suggested topic:

The objective of this master thesis is the validation of the SIMBA[#]-Model fed with radar precipitation forecasts and its comparison with the available operating data. The following questions should serve the student as guideline:

- Analysis of radar precipitation forecast data and comparison with measured precipitation
 - How well do the radar precipitation forecast data match the measured precipitations? (Comparison with measured radar precipitation data and with precipitation measured at the Zollikofen rain gauge)
 - Which forecast period makes sense? How long should be the forecast time series fed to the model?
 - How are the radar forecast data generated? Is it possible to identify systematic errors, local over- or underestimations, etc. for the Worblental region?

- Analysis of the model
 - At which neuralgic points in the model is it required to always feed real operating data? Are the available overflow detections, level and discharge measurements enough in order to design a meaningful model-reality comparison?
 - Compare the matching of the model generated data to the real data
 - How good is the model-reality matching for single events? The model produces a new forecast every 10 minutes. From this timeseries for different variables (water level tank A, discharge channel X, etc.) are generated. These timeseries should be analyzed. Up to which point in time does the forecast make sense?

There is the possibility to analyze single events as well as long timeseries over several months. One of the challenges of this work is given by the big amount of data to be analyzed. Every 10 minutes a new model-forecast is computed, meaning 144 model runs per day. For every model run simulation data vs. measured data have to be compared at different locations in the system, which at the end accounts for a large volume of data.

Specific information / Requirements

- Advanced programming skills with Python / R / other high-level programming language for data analyses are required
- Some programming experience with a more low-level programming language such as C / C++ / C# is of advantage (SIMBA[#] API is C# based)
- Good knowledge in statistics and data analysis is required
- Interest in working in a concrete project with partners from industry
- Interest in modelling, data analysis and automatization
- German knowledge is of advantage

Advisors and Supervisors

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