

Review of A Hybrid System Model of Seasonal Snowpack Water Balance

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1 Project Description

Systems with long time steps may be modeled with hybrid automata [2]. This project replicates part of the work involved with modeling the seasonal snowpack water balance and the snow-water-equivalence (SWE). The SWE is important in estimations of the water available for consumption in the winter snowpack. This is of particular importance in the desert west of the USA.

2 Progress

I have a hybrid model based on the recommended Stateflow®Simulink®design patterns [1]. I am using discrete time steps (rather than continuous) as the physical system has a large degree of variability.

3 Problems

Starting with a continuous model revealed semantic issues with embedding a continuous integrator in a SimuLink function. Switching to a discrete integrator resolved these issues but there are still questions related to how to appropriately model the differential equations.

The other significant issue is the proper calibration of the model. Typically the models produced with Stateflow®Simulink®are working with time frames in the one second region. This problem uses time frames in the hour or day region.

A minor issue is that the paper does not describe the input in much detail. The data they use is that recorded in various surveys. This will be approximated in my model with a sine wave that immitates the diurnal insolation with the trough giving up energy.

$$dI(t) = A(1.5 - \cos t2\pi) \quad (1)$$

$$I_{daily} = A \quad (2)$$

Where t is measured in days. A is the average daily insolation. A reasonable, Springtime, value for A is near $3\text{kW-hr}/m^2$.

References

- [1] Michael Carone. Design patterns for integrating simulink with stateflow. pages 175–191, 2009.
- [2] Brando Kerkez, Steven D. Glaser, John A. Dracup, and Roger C. Bales. A hybrid system model of seasonal snowpack water balance. 2010.