**Multi-room Heating System Modeled as a Dynamical System**

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**Abstract**

Everyday cyber-physical systems can be represented as dynamical systems and modeled as such. In this paper, we describe the modeling of a multi-room (four) heating system as a dynamical system using MATLAB’s Simulink add-on. Given that all our assumptions for the model hold, it can regulate all room temperatures within a reasonable range. While the model is a largely simplified version of a realistic situation, it does well to simulate the basic interactions that take place to influence the dynamics of room temperatures with a heating system.

**Introduction**

For modeling a multi-room heating system, we cannot use an asynchronous-only model with fairness conditions to properly illustrate all the factors that contribute to the fluctuating temperatures of each room; there would not be enough synchrony among tasks to ensure that the temperatures are updated simultaneously. We instead focus our attention dynamical system modeling, as we can better describe the changes in the room temperatures as the dynamics of such a system with ordinary differential equations (ODEs). Additionally, the time synchrony between components is a better representation of the real-world factors that simultaneously drive the changes in temperature.

Consider now a heating system that regulates the temperature over four connected rooms with two heaters. The temperature of each room changes linearly with the difference with the outside temperature , the difference with each directly adjacent room’s temperature, and a heater’s current effect on the room. Then the dynamics of the system can be represented by the following equation:

where and , and , and , and . represents the influence that rooms have on each other. If the rooms are not directly adjacent, then . Additionally, if . if there is no heater in room or if the heater is off and if a heater is on in the room.

The system is parameterized by the constant matrix , the constant vector , the constant vector , and the initial room temperatures in the vector . The inputs to the system are the vector for the initial placement of the heaters and .

* Parameterization
  + Should off, on, diff, etc. be included in this? Or just A, b, c, xo?
* Heater (hi) logic
  + On, off, diff, etc.

NOTES/TO DO:

-Assumptions:

-Reasonable starting temperatures and initial room temperatures, the coefficients for the matrices/vectors (A, b, c, off, diff, on, etc.) are constant, heaters can be moved instantaneously, only one heater can be in a room at a time

-Problem initialization:

-define the types of all varaibles and their ranges

-perhaps draw up a model of the system like those in the book/slides

-Verification:

-Not sure how we will verify this/if it can be done other than let it run for a large amount of time