Issues in Physical System Modeling and Simulation

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Based on the need of ongoing Physical Safety Computing (PSC) project in our group, as well as our original goal for Acumen project, I feel that a better understanding and further studying on the issues that directly affect the correctness and ease of physical system modeling and simulation are necessary. This might involve the following parts.

1. **Exact real arithmetic and analysis.**

   Real numbers are usually represented by finite strings of digits belonging to some digit set. This can only let us represent a limited subset of the real numbers exactly because many real numbers have too many digits or infinite. This result in the computation involving real numbers are usually not precise. However, in safety critical applications, those inaccuracy might leads to serious subseqences. Research has already been lead to this direction but so far not too much result are applicable in reality. To understand what people already have done and see how far we can go in this direction for our project is a promising topic in our seminar.

2. **Bond Graph and Object Oriented Modeling**

   Modeling a physical system, especially a complex system is not an easy job. Some of the difficulties lies in the fact that it might be hard to sort out the causality of the system or system equations. Bond Graph, a technique originally used in modeling engineering systems brings a new insight to simply for the task. It will be worthwhile to look at this technique in our seminar and think about how to make use of it in our related projects.

3. **Semantics of Physical System** An inspiring example for this topic is Matlab/Simulink. As we know, Matlab/Simulink has been widely used in both academia and industry for system modeling, simulation and design. However, a noticeable shortage of Matlab/Simulink is that it doesn't have a clear semantics, some of program behaviors heavily depends on the underlying simulation engine of Matlab library, which can give you unexpected or in-explainable results. Other examples are some state-of-art research on designing languages for system modeling and simulation, they all try to define precisely the semantics of their designed language. It is not dispensable to learn the experience and difficulties there and what is a good way to formalize and implement our language semantics. In our seminar, we can try to look at some papers that fits this category.