SimuPy: A Python framework for modeling and simulating dynamical systems

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Summary

Numerical simulation is an important part of the design and analysis of dynamical systems, and has become fundamental to the education, practice, and research of many math, science, and engineering disciplines. Especially in systems and controls engineering, model- and systems-based design and simulation have become a part of the dominant workflow as exemplified by tools like Simulink (The MathWorks, Inc., n.d.).

SimuPy is a framework for simulating interconnected dynamical system models and provides an open source, python-based tool that can be used in model- and system- based design and simulation workflows. Using SimuPy, it is easy to implement software representations of dynamical systems from numeric functions or from symbolic expressions using SymPy. SimuPy provides an API to connect these dynamical system models in block diagrams. The aggregate dynamics are automatically combined and can be simulated using the ordinary differential equation solvers provided by SciPy (or any solvers with the same interface). SimuPy can also handle event-based discontinuities by monitoring event functions, interrupting the integration upon a zero-crossing, and re-starting integration after using a root finder to determine the location of the discontinuity event.

The author has used SimuPy in numerical studies of nonlinear tracking control (Margolis and Ayoubi 2016, Margolis and Ayoubi (2017)). The examples and tests show that the block diagram algebra and timing formulations agree with the mathematical definitions.

References

Margolis, Benjamin W. L., and Mohammad A. Ayoubi. 2016. "Model Predictive Control of Planetary Aerocapture Using Takagi-Sugeno Fuzzy Model." In *26th Aas/Aiaa Space Flight Mechanics Meeting, Napa, ca.*

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The MathWorks, Inc. n.d. *Simulink - Simulation and Model-Based Design.* https://www.mathworks.com/products/simulink.html.