AA 279A – Space Mechanics
Winter 2017

Lecture 11 Simulink Supplement

Wednesday, 15 February 2017

Prof. Andrew Barrows

An orbital simulation can be performed by numerically integrating …

$$\frac{{}^{i}d^2}{dt^2}\vec{r} = -\mu_{central\ body}\frac{\vec{r}}{|\vec{r}|^3} + other\ specific\ forces$$

… in MATLAB using scripts and equations. Alternately, a numerical orbital simulation can be implemented in Simulink using a graphical paradigm. As an example, study the Simulink model of Pluto orbiting the Sun on the next page to see how all the pieces fit together.

Here are some notes about the Simulink example on the next page:

1) "Constant" source blocks are used to input the initial conditions on Pluto's position and velocity (in heliocentric inertial coordinates) required by the two "Integrator" blocks. The integrators' "Initial condition source" parameters are set to "external."

2) To implement specific forces other than $1/r^2$ gravity from the Sun (e.g. gravity from other bodies, drag, thrusters, radiation pressure), just add them to the input of the first integrator.

3) The Sun's gravitational constant is implemented as a "Gain" block on the right. When simulating multiple bodies, each with its own gravitational parameter and pulling on all the others, a Simulink model becomes significantly more complicated.

4) Numerical simulation parameters can be set in the "Solver" section of "Simulation Configuration Parameters." Start and stop times need to be chosen as well as the integrator type. Available variable-step size integrators include ode45 and ode113. Some fixed-step size integrators (e.g. ode5) are also available (but are not natively available within MATLAB). Study the parameters available for controlling each integrator type. The fixed-step size integrators can be used when absolute control over step size is desired.

5) Implementing a "Clock" source block allows you to access the time variable of the numerical integrator for export to your MATLAB workspace or for use in calculations.

6) There are two "To Workspace" sink blocks that send the simulation results "tout" and "yout" to your MATLAB workspace. Their "Save format" parameters are set to "Array."

Pluto's Orbit Around Sun