Princeton SATELLITE SYSTEMS

Orbit Module

The Orbit Module of the Spacecraft Control Toolbox (Professional Edition) provides functions for orbit dynamics analysis and simulation, orbit maneuver planning, and orbit elements transformations. It also includes a high-fidelity orbit propagator.

Features

Orbit Maneuvers

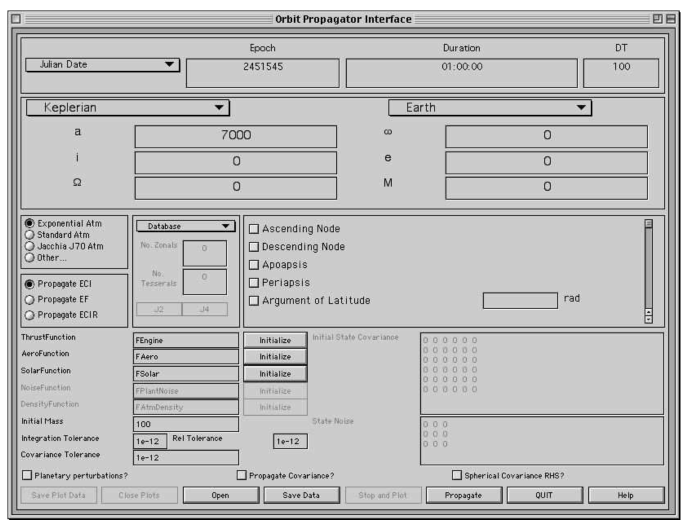
- Impulsive transfer analysis
- Low-thrust spirals and simulations
- Lambert law solver for large orbit changes
- Proximity operations such as glideslope
- Stationkeeping analysis
- Bielliptic and Hohmann transfers

Propagator

- User selectable gravity models. GEM-T1, JGM-2, JGM-3 and WGS-84 are supported. Other models can be downloaded from NASA websites.
- Ballistic propagation of the covariance matrix for the state vector. A plug in function allows the user to customize the plant noise covariance matrix.
- Propagate in ECI, ECR (earth-fixed) or ECIR. The last is an inertial frame that is coincident with EF at the start time of the simulation.
- Complete user control over the speed and accuracy of numerical integration. The propagator uses the Math- Works state-of-the-art ode113 propagator.
- The user can select the time step. The time step can be variable and negative. It can be defined by any MATLABexpression or function.
- The user can specify any one of over thirty stopping conditions.
- Flight path angle, altitude, geodetic latitude and longitude are automatically computed.
- Outputs can be saved to a mat-file for further analysis.
- Sun/moon/earth perturbations can be added if you are propagating in an earth-centered or moon-centered frame.
- A singularity-free spherical-harmonic gravity model.
- Solar pressure, earth albedo, earth radiation and drag models are included.
- Exponential, Jacchia and Standard Atmosphere atmospheric density models are included.
- The user can plug in an orbit control function to turn on thrusters during propagation.

Orbit Propagator User Interface

The propagator interface is shown below. The user can select force models, initial conditions, gravity models and stopping conditions through the GUI. In addition, the user can create his or her own control routines for feedback orbit control. All of the force models use m-files that can be customized by the user. Force models from the Spacecraft Control Toolbox can be used for high-fidelity solar pressure and drag calculations.



The GUI can be driven from a MATLABscript file for production runs. You can interchangeably work with the GUI directly or through a script. Every button on the GUI is accessible through

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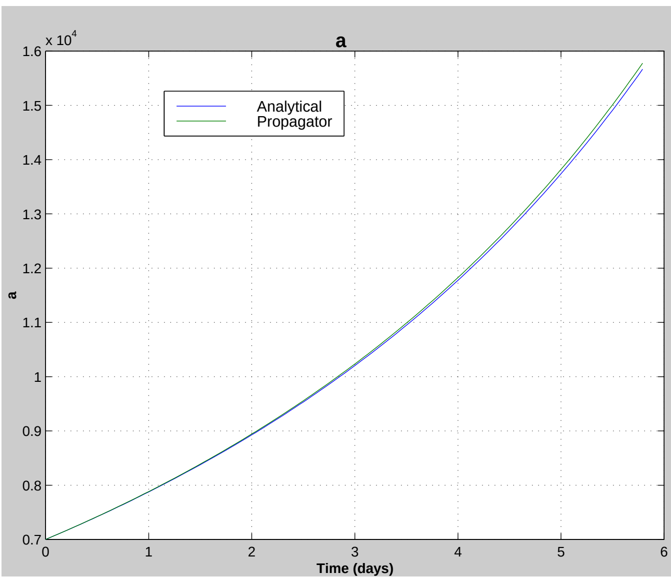
a simple function call.

An Example

If a small thrust is tangent to the orbit and its magnitude is small and constant, the semi-major axis time derivative is

$$\frac{da}{dt} = \frac{2}{\sqrt{\mu}} a^{3/2} A \tag{1}$$

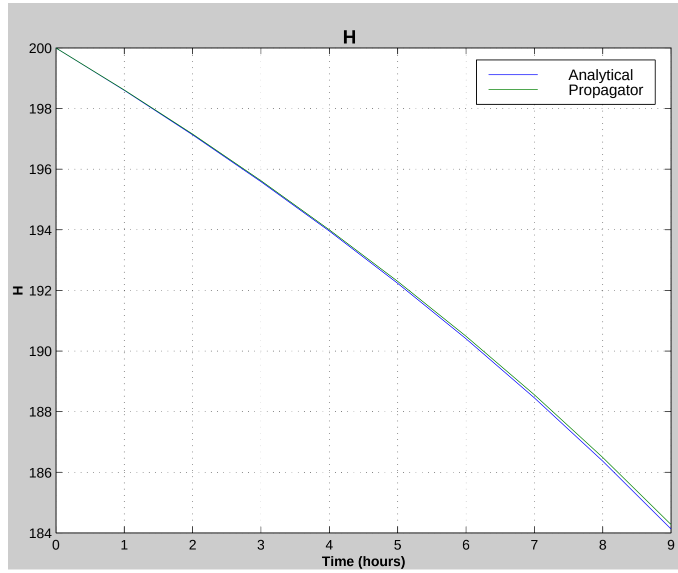
where a is the semi major axis and A is the tangential acceleration. The numerical and analytical results are shown in the following plot:



The analytical solution is

$$a^{-1/2} = a_0^{-1/2} - \frac{A}{\sqrt{\mu}}(t - t_0) \tag{2}$$

The results agree closely, demonstrating the validity of the analytical theory. The following plot shows an analytical atmospheric drag model.



The simulation results closely match the analytical theory when the simulation uses the built-in standard atmosphere model. More complex atmosphere and spacecraft surface models are also built into the package.

Full Source Code

Unlike other orbit propagation packages, the full source code is available in MATLAB.m files. This makes it easy to customize the package for your own applications.

Compatibility

The toolbox is compatible with MATLAB version 7, Windows XP/NT/2000, UNIX, and MacOS.

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