Find_Orb

Presentation by Ryan Bennett

What is Find_Orb?

Find_Orb is a package created to categorize the orbit of asteroids, comets, or any other satellite based purely off a set of distinct observations performed by astronomers. However, it can also be used for categorizing the orbit of natural satellites, including stations such as the ISS or even orbital debris.

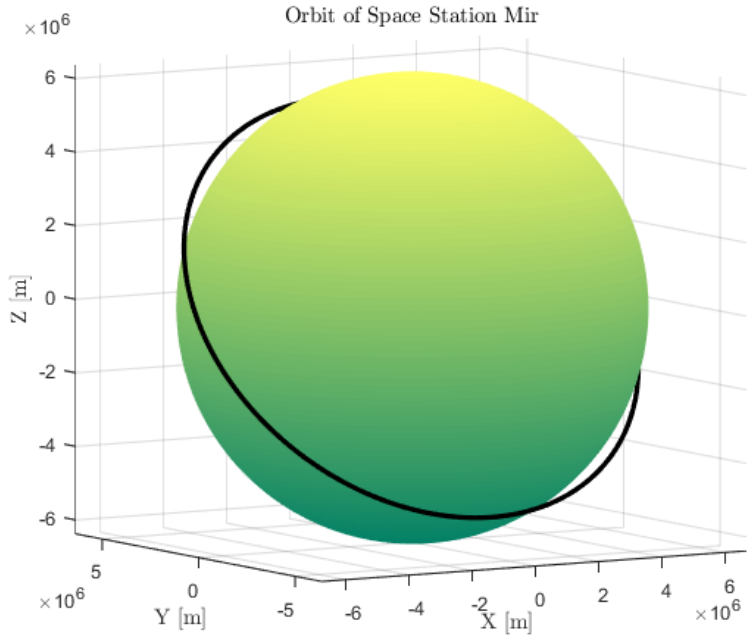
How does it work?

The package uses several numerical methods, often multiple where it can choose the most accurate one or combination of multiple models. For our uses, I will focus on what is called Gauss' Method of Orbital Determination. In this method the software only requires the location of the observer relative to the center of the earth, and the angles to the target of observation. It needs at least 3 observations, however with more observations that accuracy of the calculated orbit greatly increases.

Variables:

Station locations $\vec{R}_1, \vec{R}_2, \vec{R}_3$ … relative to the center of the earth
Direction vectors $\hat{p}_1, \hat{p}_2, \hat{p}_3$ …
Times t_1, t_2, t_3

After a long set of cross products and other vector math, the software outputs the distance and velocity vectors of the object. With just those two vectors known, a set of 'orbital elements' can be created which completely defines the desired orbit. I've run a tutorial from the GitHub page which attempts to simulate the orbit of the old Soviet space station Mir. From an external MATLAB script of mine we can plot the orbit based on these orbital elements, shown below.



Question

I would like to know how well the software can calculate orbits for objects in LEO (Low Earth Orbit) with a small number of input observations.

Experiment

My experiment would take an existing and well cataloged object in orbit around the Earth, such as the International Space Station, and feed in data at some determined time step. The calculated orbits can then be compared with the actual orbit of the station.

The timestep would need to be consistent for each trial, as observations taken in quick succession will also not be as accurate as those properly spaced out.

I limited this to objects in LEO with the idea that I could also test less known orbits, such as that taken by orbital debris.