Introduction to Flight Simulation (List 8)

Due: 7 december 2010

1. In your planet simulation program of Exercise 2, add a function that computes the center of mass and the average speed of the solar system, and the total mass.

2. Verify that the center of mass moves at constant speed, and that the average speed does not change.

3. In the program of Exercise 2, add a function that prints the angular momentum around some fixed, arbitrary point. (Not the origine of the system!)

   Verify that the complete angular momentum in the system does not change. Try it for different reference points.

4. Change the properties of gravity in some strange way (or add another force), for example by making it $O(r^{-1.5})$ instead of $O(r^{-2})$. Show that angular momentum is still preserved, and that the average speed still does not change.

5. Add some random force on one of the planets. Numerically integrate

   $$\int_{t=t_0}^{t_1} \overline{x}(t) \times \overline{F}(t)\, dt,$$

   where $\overline{F}(t)$ is the random force on the planet, $\overline{x}$ is the position of the planet at time t. Verify that the outcome of the integral equals the total change of momentum in the system.

6. Also integrate

   $$\int_{t=t_0}^{t_1} \overline{F}\, dt$$

   and verify that it equals the average change in speed times the total mass of the solar system.