

Flocking behavior in satellites formation flying

Fabrizio Paita

Institut d'Estudis Espacials de Catalunya

17/01/2013

Project overview.

► Current objective

Adapting a particular control law as a tool to develop goal oriented and collisions free trajectories for flocks of satellites, both in “ free ” space and under the influence of a gravitational field.

► The subject

Given a flock of n objects, the equations of motion for the i -th element under this law can be written as

$$\begin{aligned}\dot{x} &= v \\ \dot{v} &= \sum_{j \in \mathcal{L}(i)} \frac{H}{(\sigma + \|x_j - x\|^2)^\beta} (v_j - v),\end{aligned}\tag{1}$$

where x and v denote position and velocity, $\mathcal{L}(i)$ the set of elements that communicate with agent i and the other variables are positive constants.

Motivations and first steps.

► **Why this control tool?**

In free space, under suitable conditions, a rigid configuration is reached (same velocity and constant relative distances) exponentially fast.

A hierarchy and a free willed leader can be defined. Similar results as above can be obtained and the dynamics of the formation can be directed through the motion of the leader.

► **First steps**

Numerical implementation of the tool in the context of a simple two body problem, where circular orbits are being considered.

Relevant parameters which effect is under study include the shape and the altitude of the orbits, the effect of the acceleration variables and initial conditions and the possibility to introduce and manage a hierarchy between the elements.

Future work directions.

- ▶ **Improvement of the control law**

Additional terms can be added depending on the task required. For example, terms could be added in order to achieve tighter spatial configurations.

- ▶ **Optimal way to use it**

The focus is on applying the tool as an impulse at discrete times to maintain the formation and using a leader to control its dynamics.

- ▶ **Extension and refinement of the model(s)**

As an example, the effect of Earth oblateness on the dynamics of a formation orbiting around it is going to be considered.

Personal background.

- ▶ **Academical**

Bachelor's and Master's degree obtained at the University of Roma " Tor Vergata " .

- ▶ **Research**

Construction and analysis of a model for the dynamics of a satellite around an oblate planet in the context of non twist maps, with the satellite also subjected to the dissipative effect of tides (under development).