0.1 Reconfiguration of 2 and 3 satellite formations by electromagnetic forces

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Formations or arrays of satellites are becoming a new tool in space research, especially when multipoint measurements are required. The biggest challenge in navigating such systems is precise and long-term control of relative positions and orientations of the formation members. Especially in optical and microwave interferometric missions the control with a sub-micrometer accuracy is a key factor in obtaining satisfactory results. Usually chemical propulsion is used to generate controlling forces and torques, with a drawback of limited fuel resources, and a danger of polluting optical elements. Searching for alternative ways of multisatellite array control is very important for improve potential abilities of multisatellite remote Earth sensing systems and for interferometer space observations.

In our work, we analyse dynamics of a satellite formation flight, in which interaction between any two satellites results from multipole magnetic fields generated by coil electromagnets. Basing on Laila Elias [1], Miller and Sedwick [2] papers that deal with two-body cases, we derive control rules for a 3-object formation and provide the navigation algorithm. We analyse three different configurations of 2 or 3 satellites and show how they can be kept in a stable configuration. A more detailed description is given for a 3-satellite formation control problem. We also make simulations of simple reconfiguration process, and analyse/check stability of each formation in the presence of such disturbances as the noninertial geocentric orbital movement, non-spherical geopotential, and earth magnetic field.

[1] Laila Mireille Elias, PhD thesis: *Dynamics of Multi-Body Space Interferometers Including Reaction Wheel Gyroscopic Stiffening Effects: Structurally Connected and Electromagnetic Formation Flying Architectures,* Massachusetts Institute of Technology, March, 2004.

[2] David W. Miller, Raymond J. Sedwick, et al, *NIAC Phase I Final Report: Electromagnetic Formation Flight,* Massachusetts Institute of Technology, December, 2002.