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INSTITUTE OF
SPACE TECHNOLOGY & SPACE APPLICATIONS

Masterarbeit

Formation flying analysis for Earth-application missions

Formation flying is becoming an increasingly trendy topic in the context of space missions. Formations of smaller satellites improve mission redundancy and flexibility, whilst decreasing complexity of space systems of various applications (commercial, communications, Earth-observation, astronomy, etc.).

Naturally, flying a formation near Earth poses a challenge due to the severe influence of disturbances (gravity, J2, drag, solar radiation pressure). In addition, orbit safety needs to be ensured, particularly for crowded regions of the space surrounding the Earth, where the risk of collisions (and hence debris-generation) should be mitigated.

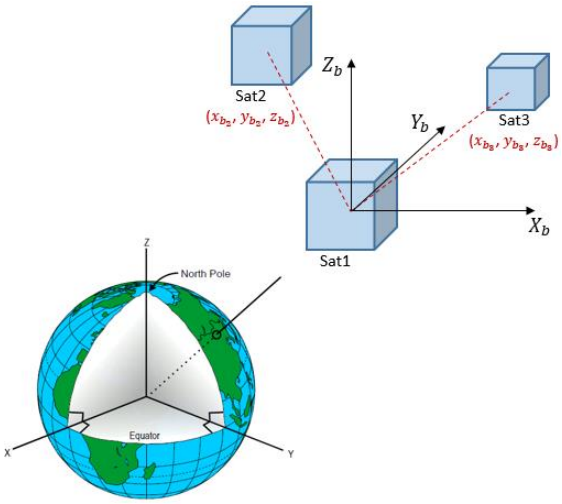

Fig. 1 Illustration of Earth-centered formation flying mission.

The aim of this study is therefore to study different formation configurations using 3 satellites and assessing the different orbital parameters corresponding to each of these configurations. After the relative orbital parameters are identified, an assessment of collision risk and delta-V (ΔV) expenditure should be pursued for different orbital altitudes (LEO, GEO, HEO).

For this study, one can consider the four main disturbance components and assume spacecraft are point masses. Applicants should be familiar with the basic elements of orbit transfers. A personal interest in programming (Matlab) and mathematics is desirable. Autonomy and proactiveness are encouraged.

Goal

It is intended that the applicant identifies relevant formation configurations and then analyses the ΔV requirements for formation-keeping maneuvers (for each of the configurations) and assess on a preliminary basis the risk of collision under uncontrolled dynamics. Two software tools will support this study: SCT (Satellite Control Toolbox, developed by Princeton University) and GMAT (General Mission Analysis Tool, developed by NASA). The following tasks should be used as guidelines:

- Familiarization with the concept of relative orbital parameters (relevant literature will be provided)
- Familiarization with SCT and GMAT environments and the work developed so far.
- Identification of relative orbital parameters and their effect on formation configurations and Simulations (SCT).
- Evaluation of ΔV for formation-keeping and collision risk (GMAT)
- Documentation of the results – in English.

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