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## Aufgabenstellung für die Projektarbeit SS 2019

### Title:

### Analysis of a CubeSat-based ADR-Mission

#### Analyse einer ADR-basierten CubeSat-Mission

Datum: 01. Mai 2019

Ihr Zeichen:

Ihre Nachricht vom:

Unser Zeichen: EnS/KBL

Unsere Nachricht vom:

A safe and secure space environment is a requirement for all current and future space activities. Analyses performed by ESA and NASA indicate that the only means of sustaining the orbital environment at a safe level for space operations will be by carrying out active debris removal and end-of-life de-orbiting or re-orbiting of future space assets. While new mitigation standards need to be adopted and reliability to be improved, it is expected that even with strict compliance with mitigation guidelines and high adherence to reliability best practices, considering the number of satellites involved, ADR will remain a vital necessity to stabilize the space debris environment. The needed ADR solution must be affordable and achieve a high technology readiness level.

The key to success in achieving reliable and efficient removal of space debris is to focus on the recent evolution trends in space industry and take advantage from advances in space technology such as CubeSat COTS-parts to develop an adapted solution to the evolving space debris issue. The solution should be thoroughly tested and demonstrated in relevant environments.

To realize this, a series of technological challenges has to be addressed. The Goal of this work is to investigate **CubeSat-based ADR** mission. In particular the **mission design and the CubeSat system design** are to be analyzed. The following detailed tasks must be performed:

1. First of all, a literature research has to be performed based on the supervisor's previous works [1], including the following topics:
  - a. Rendezvous mission and satellite design overview.
  - b. Bio inspired Docking technology.
  - c. CubeSat Hardware overview.

- d. Familiarizing with GMAT and QuSAD software.
2. Subsequently, the **mission and system design are to be defined** for a CubeSat based ADR mission. The work includes the following steps:
  - a. Define relevant mission scenario for CubeSat based ADR using methodical approaches based on previous works [1,2] and the results from task 1. This includes the specification of each mission phase in terms of number of: orbits (time), used sensors, used actuators, etc...
  - b. Select a Bio-inspired docking concept based on the results of supervisor's on-going work and results from task 1.
  - c. Define relevant CubeSat configurations based on basic budgets estimations and the results from [2].
3. Deliver a **proof of concept for mission and CubeSat design**. The Proof focuses on the feasibility of the de-orbit phase based on the selected CubeSat configurations and the constraints dictated by mission design and the CubeSat calculated budgets. The work includes the following steps:
  - a. Update the database of the software tool QuSAD with all relevant subsystems.
  - b. Perform detailed Budget evaluation of identified CubeSat configurations using methodical approaches based on the results from task 1, 2 and the report from [2].
  - c. Perform detailed de-orbit sensitivity analysis of the selected CubeSat configurations using GMAT software.
  - d. Define envelope of target parameters which can be removed using the selected concept
  - e. Evaluate the feasibility of CubeSat-based ADR for prominent announced constellations such as Starlink, OneWeb, etc...
4. The work described in points 1 to 4 shall be elaborated in writing and presented in a final presentation. The results, raw data as well as the created software tools are to be made available to at least one IRAS employee for archiving and further processing.

At the beginning of the work, a definition and description of individual work packages (Work Breakdown Structure, Work Package Description) are to be compiled to a project schedule. The work has to be done according to the guidelines of the Institute of Space Systems and has to be handed over in two copies (original and copy).

The Institute of Space Systems supports the scientific publication of the results of student work with prior approval. However, the results of the work may only be carried out after consultation with the supervising institutions. This work may be provided to third parties only after consultation with the supervising institutions. The work remains the property of the supervising institutions.

#### Literature:

- [1] **M.K. Ben Larbi et. al.**, *Active Debris Removal for Mega Constellations: CubeSat Possible?*, 9th International Workshop on Satellite Constellations and Formation Flying, 2017  
[2] **M. Lettau**, *Rendezvous Architecture and Validation Process for CubeSat based Active Debris Removal*, Master thesis, TU Braunschweig, 2019

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