Optimal control applications for the *Clean Space* initiative

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The *Clean Space* initiative was launched by the European Apace Agency in order to develop technologies that are adequate for the removal of space debris that orbit the earth. A branch of this study, *e.Deorbit*, investigates the viability of de-orbiting inactive satellites by a chaser vehicle that will approach the satellite, grab it, and start a series of manoeuvres that cause the ensemble to be burned in the Earth atmosphere. This lecture presents two M. Sc. dissertations [1], [2] that address optimal control applications to this problem. The dissertation [1] demonstrates how the motion planning associated to the rendez-vous of a chaser vehicle with respect to a moving target vehicle in orbit can be formulated in an optimal control framework, and solved using numerical methods to approximate the necessary conditions provided by Pontryagin's Principle. The dissertation [2] addresses passive Fault-Tolerant Control (FTC) design techniques for close range manoeuvres in these missions, considering situations in which one of the chaser jet actuators fails. The strategy for FTC design consists in the consideration of the fault as increasing the uncertainty level and designing a robust controller using the $\mathcal{H}_\infty$ method. In both cases the design methodologies are explained, together with illustrative simulation results.

References

[1] G. U. Afonso (2017). *Optimal control algorithms for rendez-vous applications*, M. Sc. dissertation, Instituto Superior Tcnico, Universidade de Lisboa.

[2] David C. V. Cordeiro (2017). *Fault-tolerant control for terminal rendez-vous in active removal of space debris*, M. Sc. dissertation, Instituto Superior Tcnico, Universidade de Lisboa.

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