Vision Based Navigation Sensors for Spacecraft Rendezvous and Docking

Space missions have recently entered a new stage where concerted mission, i.e. mission where multiple space segments cooperate in forming a combined platform on which improved or new physics or services can be achieved. The best-known existing example is probably the TDRSS constellation of 24 active spacecraft together providing the global positioning service dubbed GPS. However, several other present missions provide augmented performances based on multi space segment configuration, e.g. the GRACE twin spacecraft form together the world's hitherto most accurate gravimeter, which has provided new information and insight into gravitational related physics as diverse as dessert growth, ocean circulation, gravity anomaly mapping and precipitation and climate models. Plans and projects for future multi segment missions are plenty, with missions from all major space agencies in progress. Denmark has, with DTUs design of the Swarm mission, ESAs next Earth Observation Programme magnetic mapping mission, and DTUs participation in GRACE, ELISA and Alsat2, a leading role in designing and verifying sensor systems for this new class of spacecraft. The Swedish led PRISMA mission is a technological demonstration mission, where all aspects of space rendezvous and docking to both a cooperative and a non-cooperative target is researched, with the use of novel methods, instruments and technologies. Amongst other equipment, DTU has delivered a vision based sensor package to the Main spacecraft of this constellation, providing both position and pose information for the Target vehicle. This dissertation will describe the study, implementation and verification methods that has led to the realization of this optical Vision Based Sensor (VBS), which is used on the PRISMA mission. On June 15th 2010 the PRISMA satellites were launched successfully into orbit, and after the commissioning phase and system check-out the two joined satellites were separated August 9th, initiating the operation phase of the mission. The Early Harvest started August 30th for the Far Range VBS CHU and September 9th for the Short Range VBS CHU, from where the first in-flight data and analysis will be presented and discussed in this dissertation. While writing, the PRISMA mission is continuously providing new VBS data on a daily basis.

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