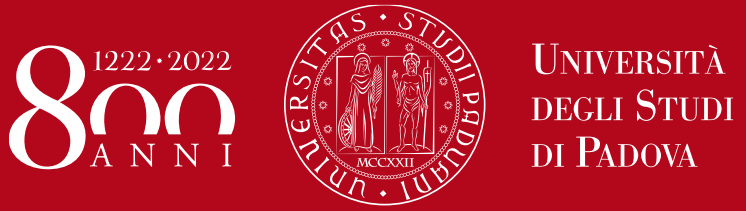


Application of autonomous On Orbit Assembly to On Orbit Servicing and Active debris Removal Missions

Federico Basana - 37^{th} Cycle

Supervisor: Dr. Francesco Branz

Meeting - 27/10/2021

Outline

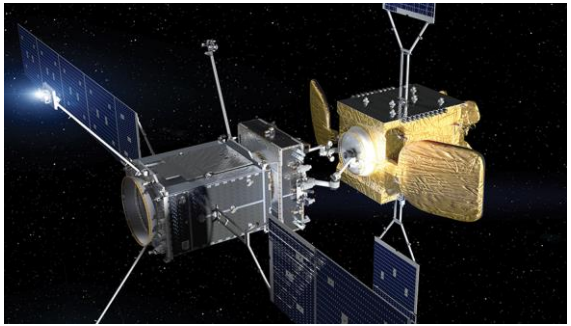
- On Orbit Activities overview
- Doctoral work objectives
- Research activities
- Work organization

On Orbit Servicing

- On Orbit Servicing (OOS)
  - Non-contact support
  - Orbit maintenance or modification
  - Repair, assembly
  - Refuelling and commodities replenishment
  - Active Debris Removal

MEV-1

Orbital Express - DARPA



Micro/nano satellite + On orbit assembly

Micro/nano satellites

Micro: mass between 10 – 100 kg
Nano: mass between 1 – 10 kg (CubeSat)

On Orbit Assembly

Assembly of large structures in space

AAReST mission

Doctoral work objectives

Can OOA be applied to OOS/ADR missions?

Possible advantages:

- High versatility
- Failure resistant
- Cheap technology

Challenges:

- Not fully developed technology
- Assembly phase
- Close Proximity Operations (CPOs)

Doctoral work objectives

Analysis of OOS/ADR missions employing OOA of micro/nano satellites

An OOS/ADR mission which serves multiple targets will be studied. In the mission the OOA of micro/nano satellites will be employed to service the targets.

Definition of new strategies for autonomous OOA of micro/nano satellites

Starting from the development of CubeSat sized modules, the assembly architecture will be defined and innovative solutions for autonomous OOA of micro/nano satellites will be investigated and simulated.

Study of the target capture phase with an assembly

The assembly resulting from the OOA operations will be studied during the capture phase of different targets. Close Proximity Operations will be studied (i.e. from the assembly release to the capture of the target)

Validation of numerical simulations through experimental activities

Methodology

Mission Analysis

- Multiple targets service mission definition
- Multiple targets service mission simulation

Autonomous OOA of micro/nano satellites

- Definition of new strategies for autonomous OOA of micro/nano satellites
- Development of modules of the assembly
- Facility development
- Validation tests campaign

Methodology

Target Capture Phase

- Close Proximity Operations (CPOs) with robotic arm simulation
- Assembly Close Proximity Operations (CPOs) study
- Robotic Arm vs. Assembly comparison
- Assembly Close Proximity Operations tests

Timing

PHD STUDENT	Federico Basana	DATE	22/10/2021
PHD THESIS	Application of autonomous On Orbit Assembly to On Orbit Servicing and Active Debris Removal Missions	ADMISSION TO	First Year

WBS NUMBER	TASK TITLE	% OF TASK COMPLETE	FIRST YEAR												SECOND YEAR												THIRD YEAR											
			T1			T2			T3			T4			T1			T2			T3			T4			T1			T2			T3			T4		
			O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
1	Mission Analysis																																					
1.1	Multiple targets service mission definition	0%																																				
1.2	Multiple targets service mission simulation	0%																																				
2	Autonomous OOA of micro/nano satellites																																					
2.1	Definition of new strategies for autonomous OOA of micro/nano satellites	0%																																				
2.2	Development of modules of the assembly	0%																																				
2.3	Facility development	0%																																				
2.4	Validation test campaign	0%																																				
3	Target capture phase																																					
3.1	Close Proximity Operations (CPOs) with robotic arm simulation	0%																																				
3.2	Assembly Close Proximity Operations (CPOs) study	0%																																				
3.3	Robotic Arm vs. Assembly comparison	0%																																				
3.4	Assembly Close Proximity Operations test	0%																																				
4	Writing PhD thesis and reports																																					
4.1	Writing reports	0%																																				
4.2	Article redaction	0%																																				
4.3	Writing PhD thesis	0%																																				

Thanks for the attention