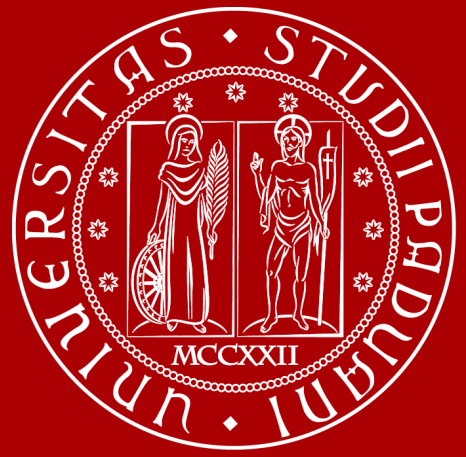

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Innovative Technologies for Autonomous Navigation and Capture of Uncooperative and Unprepared Satellites

Lorenzo Galante - 41th Cycle

Meeting - 12/11/2025

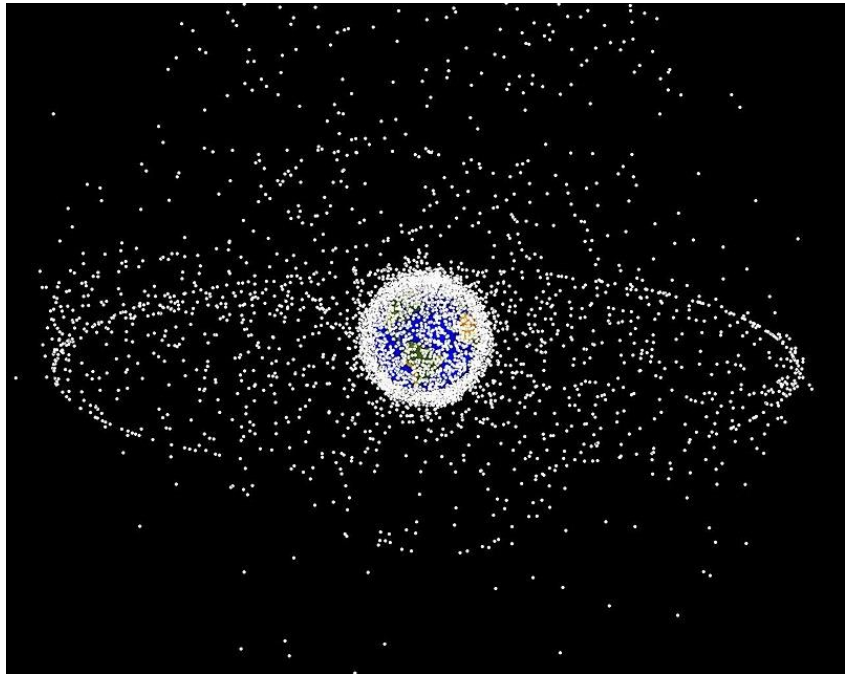
1. Introduction
2. Project description
3. PhD proposed approach
4. Research goals
5. Methodology
6. Work plan

1 Introduction

Increasing congestion of Earth's orbit threatens the sustainability of space activities

An extremely critical aspect is the capture and disposal of non-cooperative targets, especially in tumbling motion

These objects lack transponders, markers, or docking fixtures that could facilitate capture



2 Project description

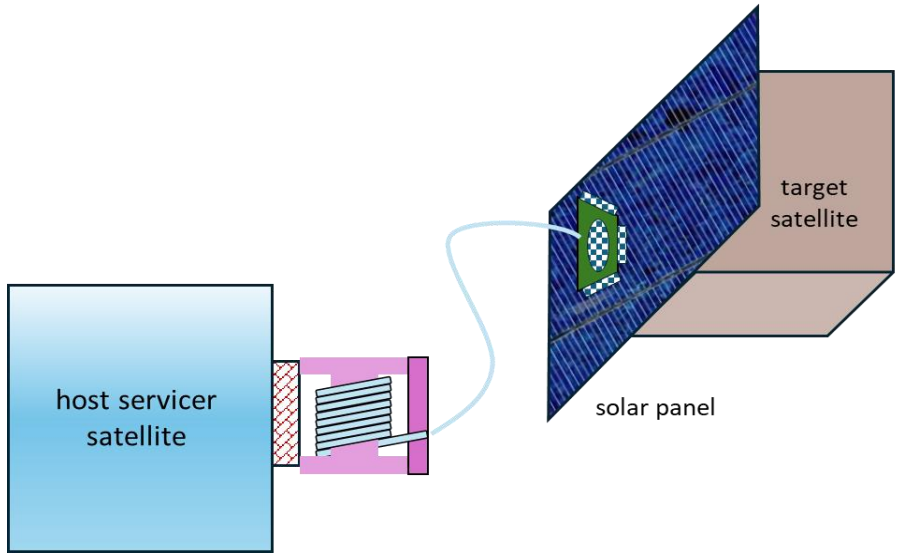
To address these challenges, the European Commission funded the gEICko (Gecko-inspired Innovative Capture Kit for uncooperative and unprepared orbital assets) project

The aim is to develop a novel capture kit for non-cooperative objects

Gecko-inspired micro-patterned dry adhesives (MDAs) to allow secure and reversible attachment to a wide range of surfaces

3 PhD proposed approach

Capture kit: Tip mass equipped with MDAs connected to the chaser spacecraft via a non-conductive tether



Focus on design, simulation, and experimental validation of a prototype capture kit

4 Research goals

Design and implement a modular simulation framework integrating tether dynamics, target models, pose estimation and tracking, and GNC algorithms

Design and prototype a tether deployment mechanism compatible with MDA-based capture

Validate the concept through simulation and experimental testing in relevant environments

5 Methodology (1/2)

State of the art definition

- Active debris removal systems analysis
- Operational context and main challenges identification
- Mission scenarios and ConOps definition

Design phase of the tether deployment mechanism

- Requirements definition
- Mechanism and interfaces design

5 Methodology (2/2)

Simulation framework development phase

- Dynamic model development
- Environmental model implementation
- Validation through benchmark scenarios and performance analysis

Testing phase

- Detailed design
- Prototype manufacturing and assembly
- Experimental campaign

6 Work plan (1/2)

TASK 1: Literature Review and Mission Definition

TASK 2: Computer Vision-Based Target Detection and Approach Guidance

TASK 3: Simulation Environment for Tether-Based Capture Systems

TASK 4: Tether Deployment Mechanism Design

TASK 5: Experimental Test on Prototype

TASK 6: Thesis Writing and Dissemination

6 Work plan: GANTT (2/2)

	TASKS	YEAR 1				YEAR 2				YEAR 3			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
T1	Literature Review and Scenario Analysis												
	Mission Scenario Definition and Characterization												
	Concept of Operations (ConOps) Development												
T2	Pose Estimation and Tracking Algorithms												
	Integration within GNC simulation framework												
	Experimental Validation												
T3	Tether Dynamics Characterization and Control Design												
	GNC for Capture of Non-Cooperative Targets with Tethered Systems												
	System Validation with Known Scenarios												
	Vision-Based Module Integration												
	Simulation of Specific Mission Scenarios												
T4	Conceptual Design Study												
	Mechanical and Functional Design												
	Prototype Testing and Validation												
T5	Prototype Realization and Test Preparation												
	Experimental Campaign												
	Dataset Acquisition and Preparation												
T6	Data Analysis and Model Refinement												
	Thesis Writing and Dissemination												

Thank you for your attention!

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