Orbital Debris Identification Network

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ODIN

Orbital Debris Identification Network

ODIN represents a critical leap forward in satellite testbed capabilities for use in engineering instruction environments as well as for demonstration of Space Situational Awareness research.

Introduction

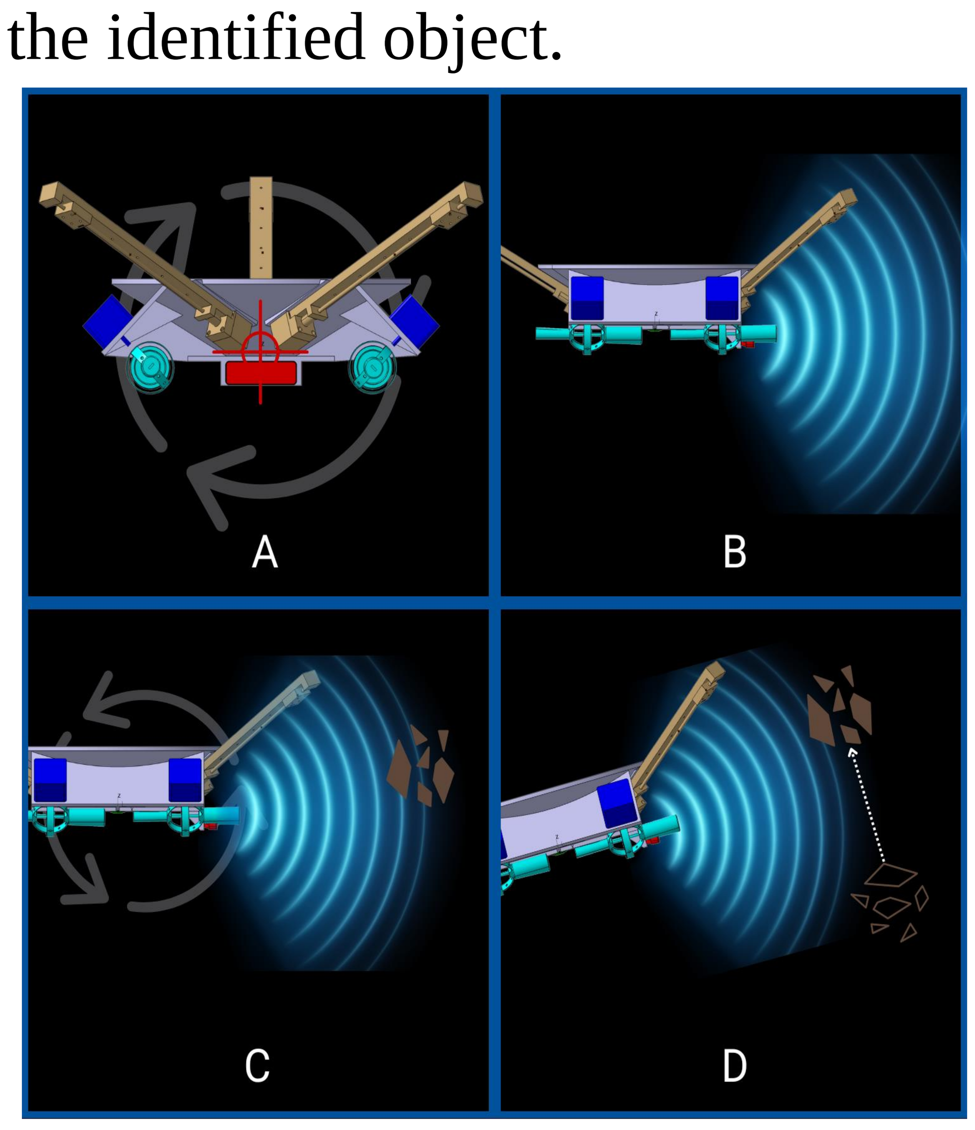
The exponential growth of space activities has led to a substantial increase in orbital debris, posing critical threats to space operations. This debris travels at velocities upwards of 18,000 mph (8000 m/s) around Earth [1]. Presently, over 28,000 objects are tracked, while millions of smaller, untracked fragments remain, each capable of inflicting significant damage on operational spacecraft [2].

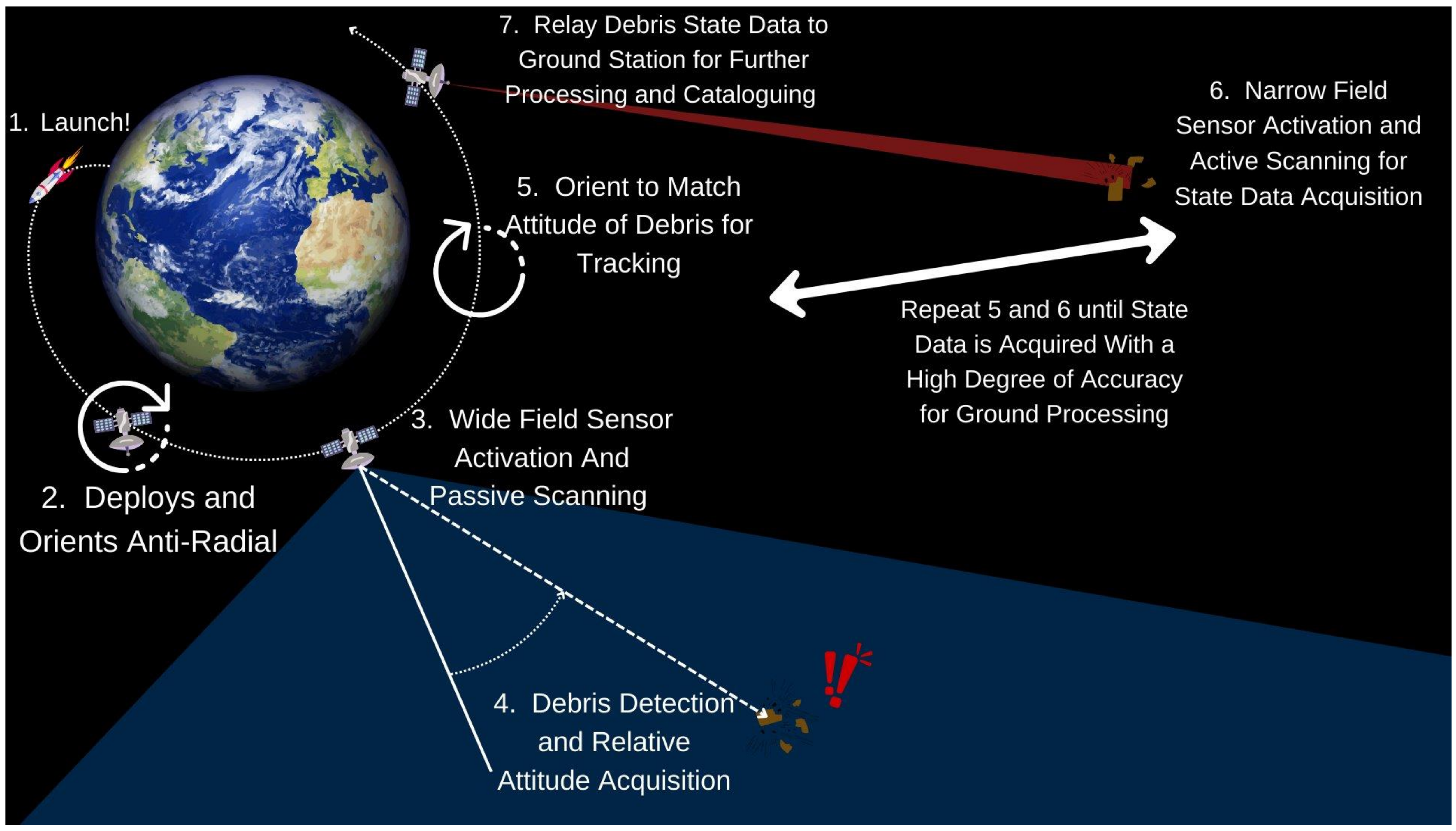
System Overview

ODIN is the prototype for a networked and proliferate space vehicle that is equipped with optimized attitude control and a multispectral sensor package. This platform will be used to support the Space-domain Situational Awareness mission to maintain the sustainability of space operations in critical regions of Earth orbit.

Operations

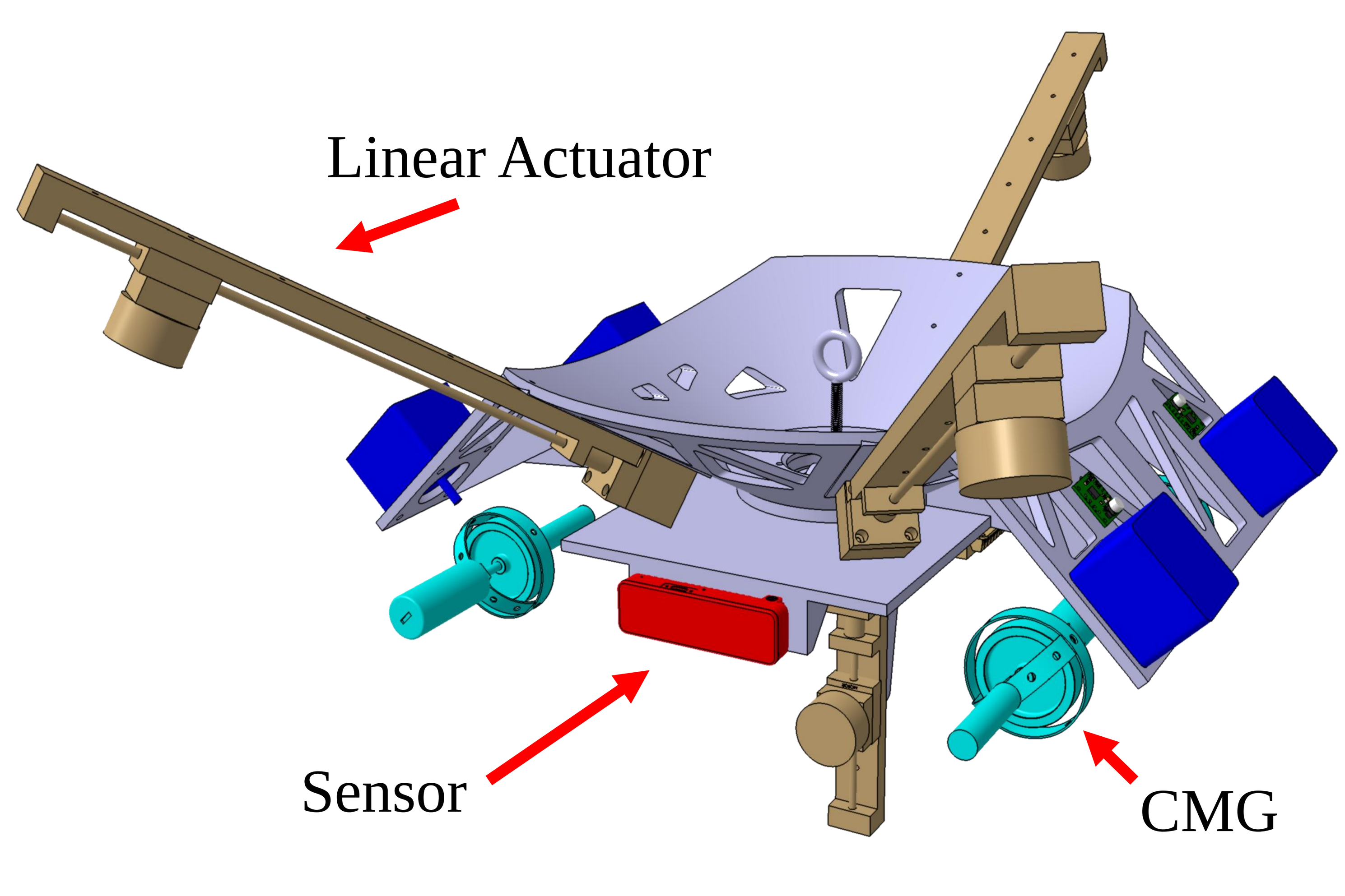
A) ODIN will calibrate its mass moment of inertia and the position of its center of gravity using linear actuators.
B) ODIN will command an attitude change to point at a known direction.
C) ODIN will begin scanning with its wide field sensor suite to identify and track moving objects.
D) ODIN will use its CMGs to adjust its attitude to point and track the identified object.





Subsystems

The Command Subsystem is the hardware and software that processes attitude control, center of mass control, inertial calibration, optical sensor data, and IMU state data.
The Controls Subsystem encompasses the hardware necessary for actuating attitude change and center of mass calibration.
The Sensor Subsystem handles the detection of nearby objects relative to ODIN by utilizing two monochrome sensors in stereo and one full spectrum optical sensor.
The Power Subsystem provides adequate power to each component onboard ODIN.
The Structures Subsystem provides the vehicle chassis and exterior structure.



Model of Proposed ODIN Prototype

Analysis

- Finite Element Analysis of critical structural components
- Modal analysis of chassis and gimbal
- Vibration testing
- Power delivery testing
- Control law equation verification
- IMU data acquisition

Critical Requirements

- Roof CMG array
- Independent power system
- Transportable design for classroom use case
- Self balancing center of mass along three degrees of freedom
- Hanging superstructure
- Point and track detected objects using CMG array and control law

References

[1] D. Kessler and B. Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," Journal of Geophysical Research, vol. 83, no. A6, pp. 2637-2646, 1978.
[2] U.S. Space Force, "Space Surveillance Network Fact Sheet," 2020. Available: https://www.spaceforce.mil/factsheets/SSN.