Università
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DOCKS: CubeSat Compact Solution for Ultra Close Proximity and Docking

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Space Rider Observer Cube - SROC

Prime contractor:

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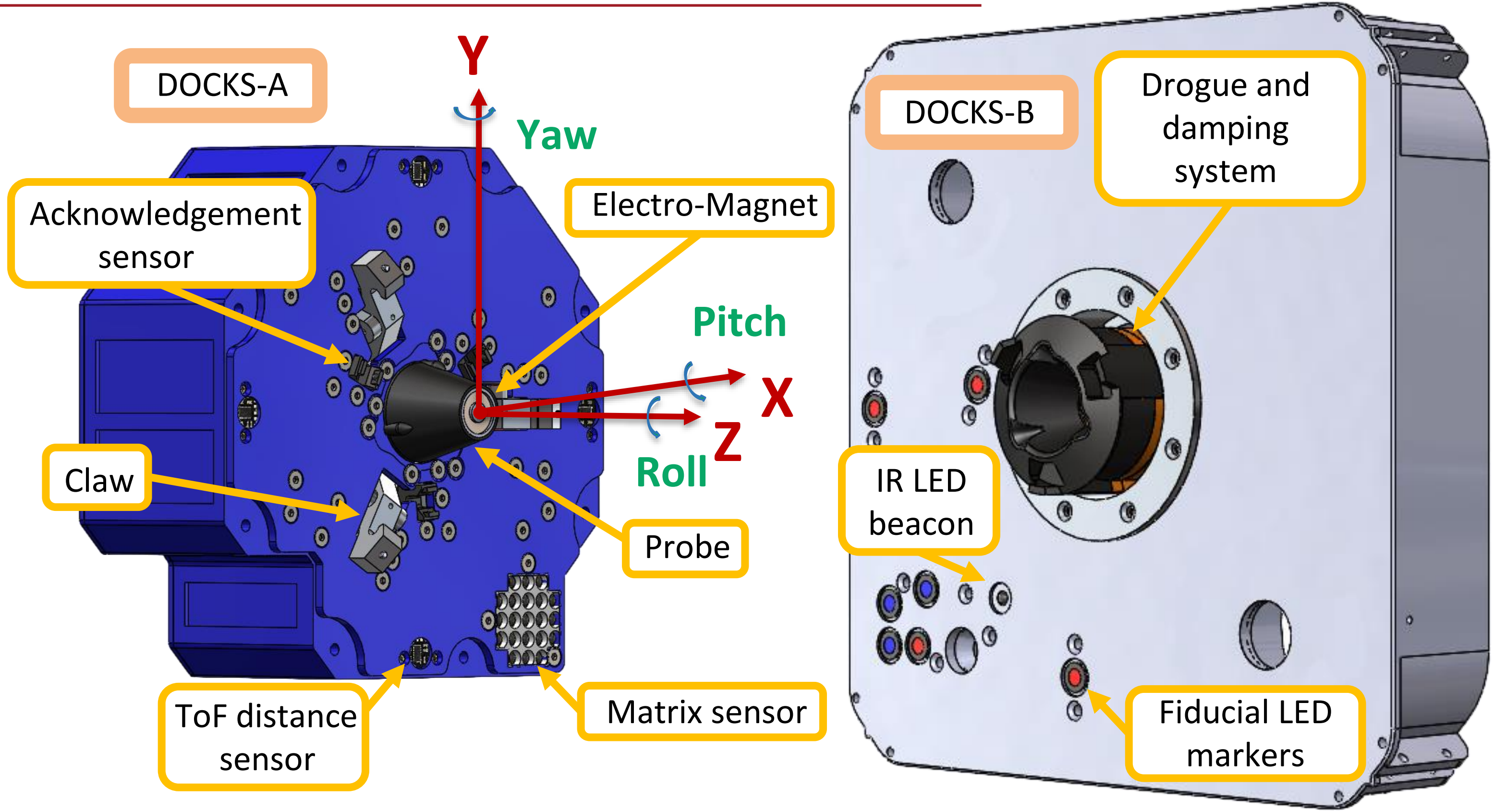
Sub contractor:

STELLAR PROJECT

Università degli Studi di Padova

Politecnico di Torino

DOCKS – DOCKing System



Ultra Close Proximity Navigation

Equipped with a set of four types of sensors and a dedicated on board computer, DOCKS-A is able to compute the relative pose w.r.t. DOCKS-B from 1 meter of distance up to contact.

- Inertial measurement unit (**IMU**)
- Navigation Camera (**NavCam**) and fiducial LED markers
- Time of Flight (**ToF**) sensors
- **Matrix** sensor

Ultra Close Proximity Navigation - NavCam

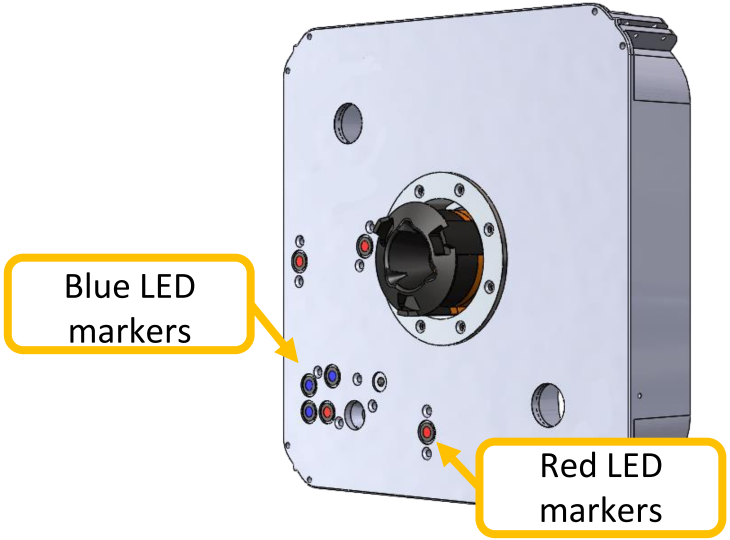
The NavCam sensors is employed from approx. 1 m to approx. 0.05 m.

Two sets of visible LEDs are used, blue and red, to work in different ranges.

Conceptually the sensor works as follow:

1. The camera takes an image of the fiducial LEDs markers;
2. Computer vision algorithms are applied to the image to reconstruct the position of each LED marker;
3. The position of each LED is reprojected to obtain the 3D relative pose.

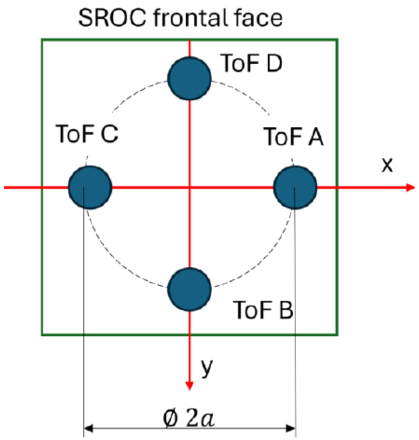
This sensor is characterized by a good accuracy in the reconstruction of the relative pose, the errors are approximately 5.5 mm for the position, and approximately 5 deg for the orientation.

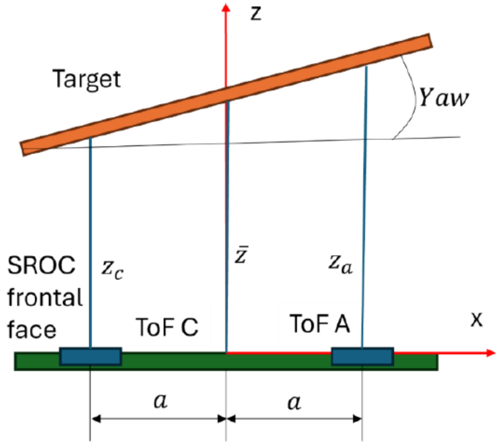


Ultra Close Proximity Navigation - ToF

Four industrial-grade Time of Flight sensors are placed in a cross pattern on the face of DOCKS-A. With this layout, DOCKS can retrieve the distance along the +Z axis and the orientations around the X and the Y axis.

The selected sensors work from a relative distance of ~0.10 m to ~0.03 m.





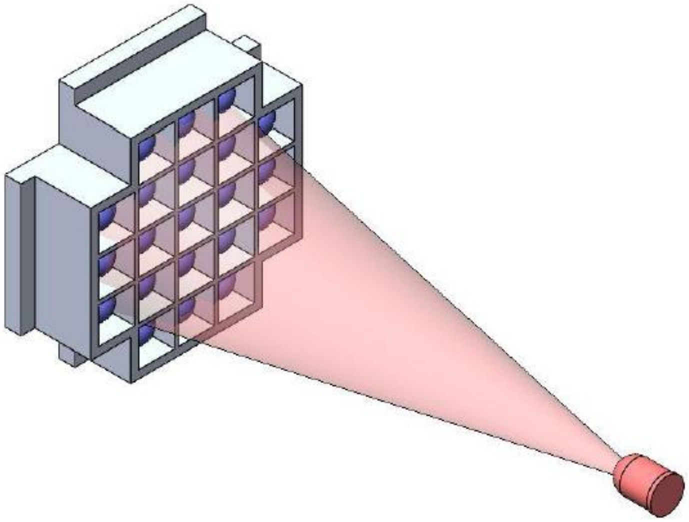
Ultra Close Proximity Navigation - Matrix

The matrix sensor is employed to retrieve the relative position on the X-Y plane from 0.05 m to 0 m.

The sensor is composed by two parts:

- one infrared (IR) LED beacon mounted on DOCKS-B
- a pattern of 21 phototransistors mounted on DOCKS-A.

The IR LED activates different phototransistors depending on the relative position. The relative in-plane position is computed as the distance between the centre of the matrix and the centroid of the activated phototransistors



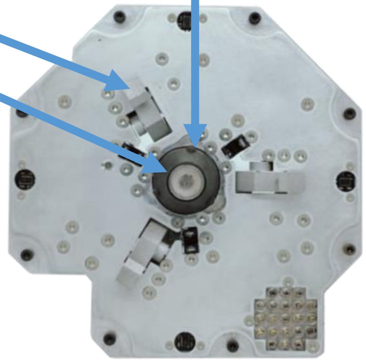
Docking mechanism

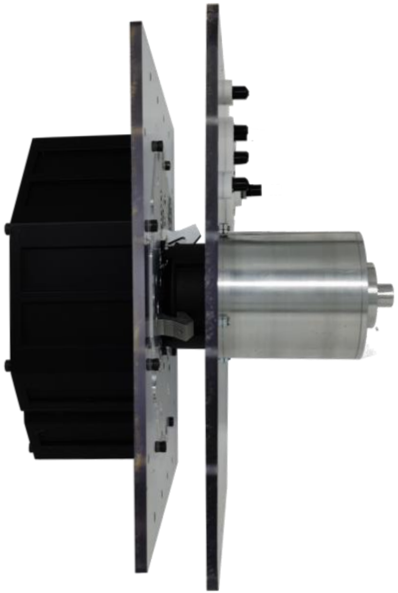
The docking mechanism is based on a **probe drogue** design aided by three gripper-like **claws** to ensure the hard docking.

The soft docking is granted by an **electro-magnet** placed inside the probe.

In addition, DOCKS hosts:

- Damping system
- Safety release system
- Electro-static discharge (ESD) management system

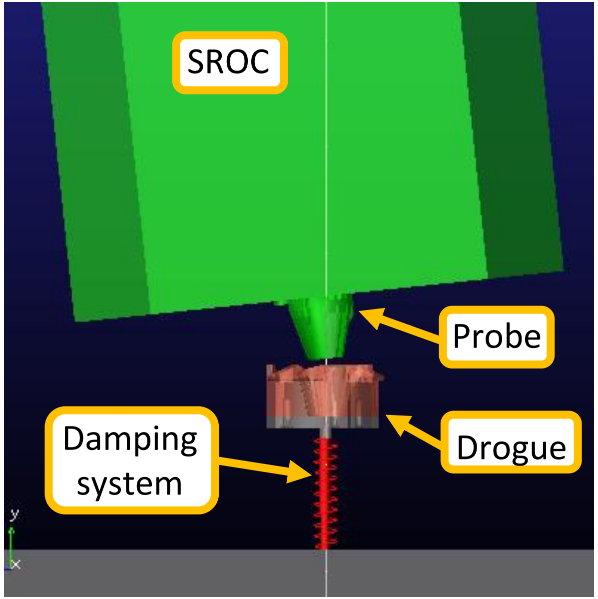




Docking mechanism – Damping system

To ensure a safe docking manuevre and to limit the risk of a rebounce, DOCKS is equipped with a damping system based on silicone damping elements.

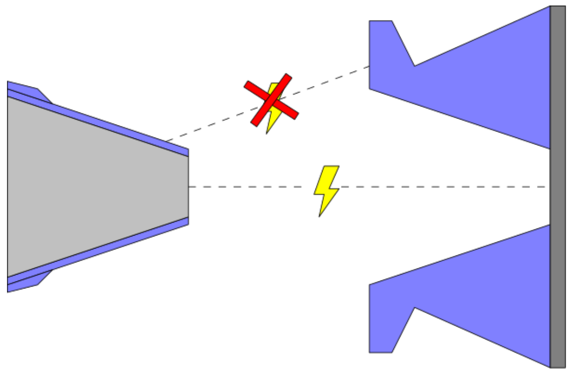
The dimensioning of the system was performed through multibody simulations using Hexagon ADAMS View.



Docking mechanism – ESD management system

To mitigate the risk of damage on both spacecrafts caused by an electro-static discharge during the docking procedure, a “preferred” path approach is implemented.

The discharge will forcibly happen between the electromagnet and the ferromagnetic plate due to geometric constrains.



Probe skin
+
Electromagnet

Drogue
+
Ferromagnetic plate

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Thank you

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