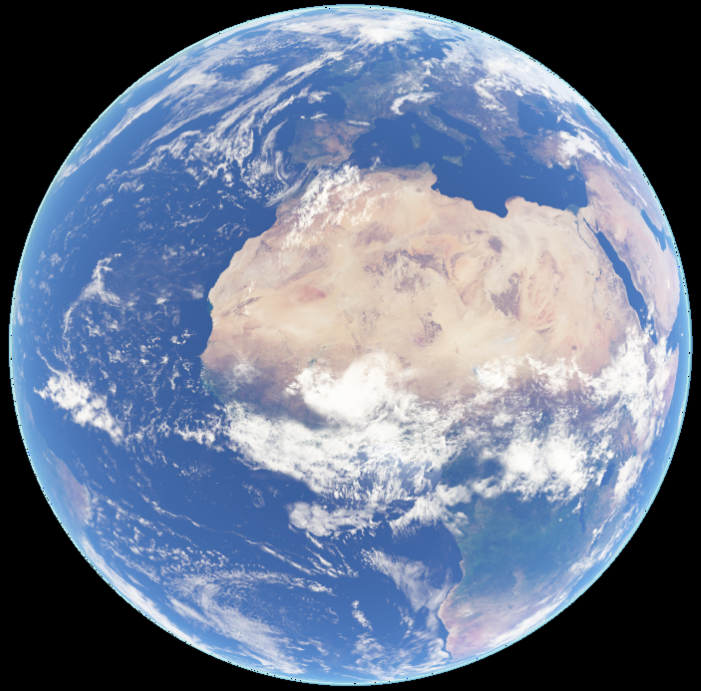
Clean Space Industry Days 2021



Building autonomy in space: a prototyping platform for autonomous space missions

Blackswan Technologies

Problem

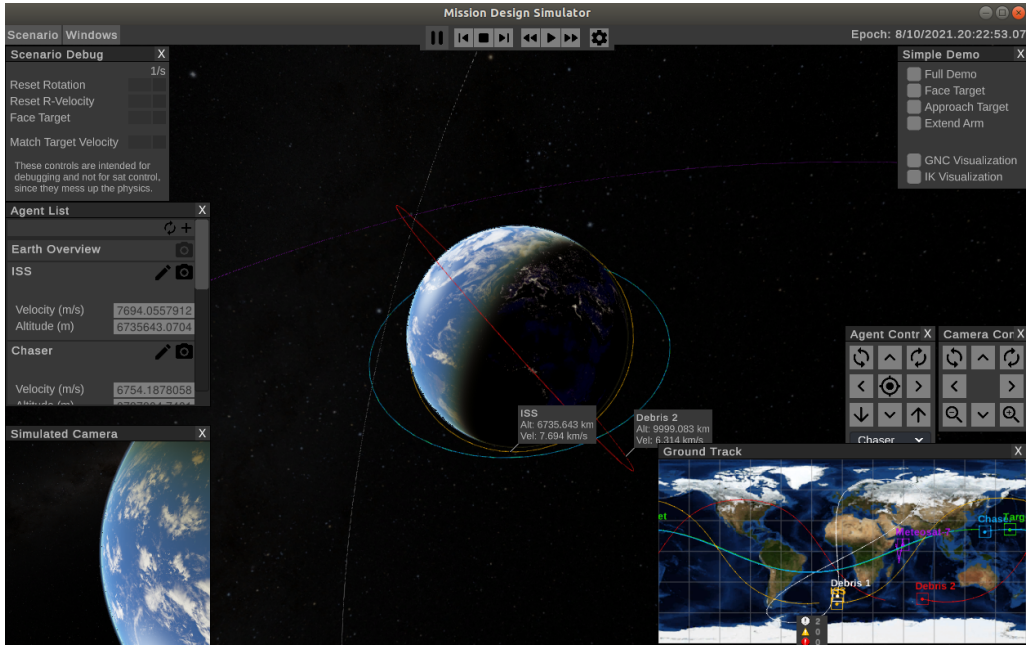
Lack of standardized frameworks and simulation tools for autonomous mission development

- Low to no re-usability of previous code and tools. Usually everything is re-written from scratch for a flight mission
- Have to use multiple packages/tools and connect the results together. This reduces accuracy and introduces errors
- Lack of data for training and testing DL models and CV algorithms for space applications
- Verification and validation of flight code through standardization of methods

Mission Design Simulator (MDS)

A simulations **platform** that helps teams develop complex **autonomous** missions

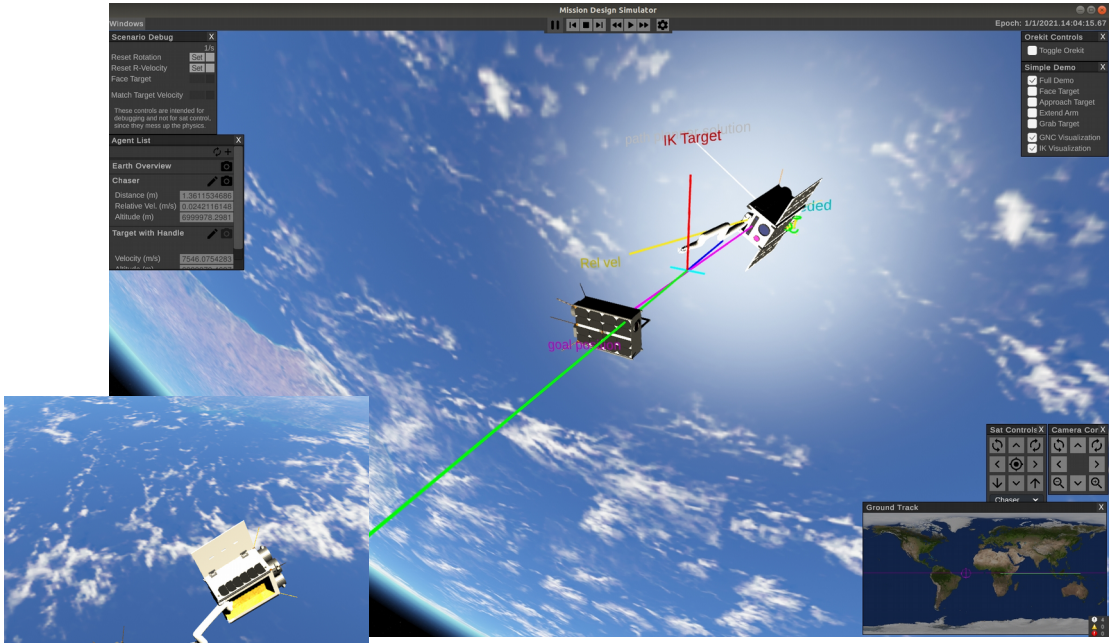
- Orbital mechanics integrated with multi-body dynamics
- Photo-realistic environment with real-time operations
- Synthetic image dataset generation
- Language agnostic API

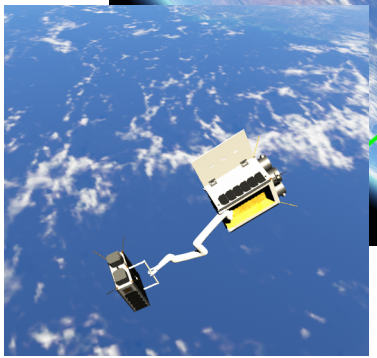


IOS example scenario

De-orbiting a satellite using robotic capture

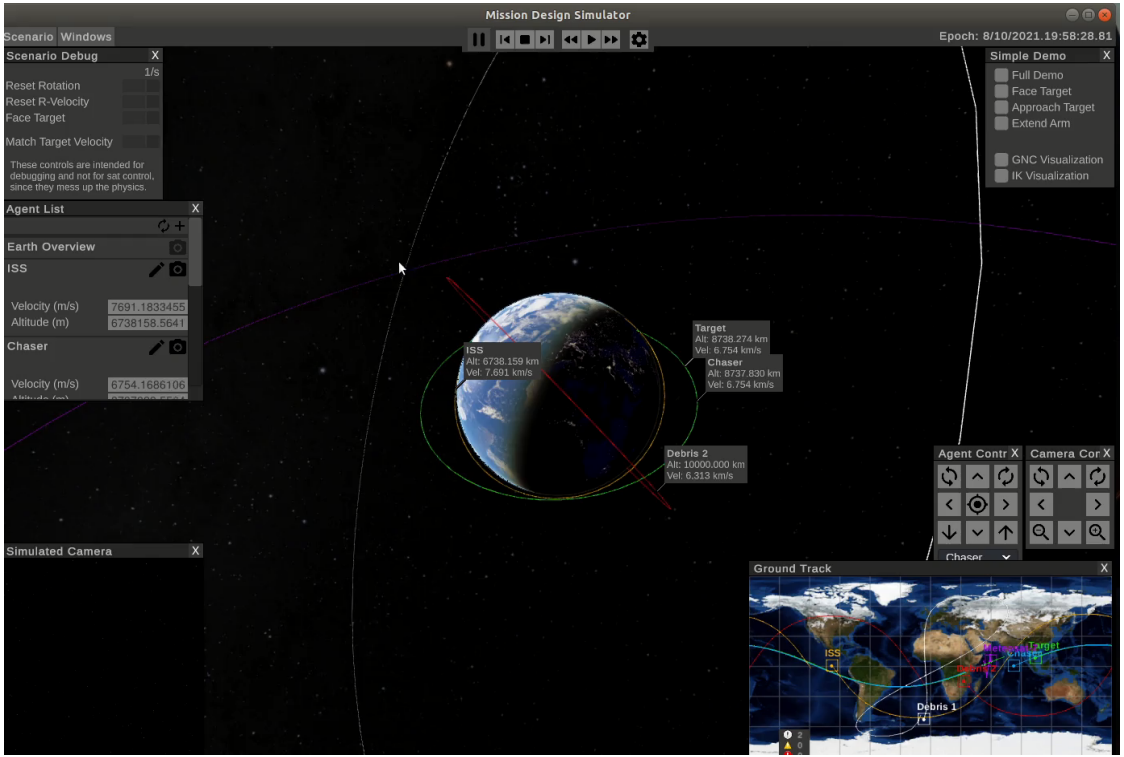
- Running navigation and robotics algorithms in real-time with visual cues
- Simulated multi-body dynamics with orbital mechanics
- Modular instruments for GNC





Orbital mechanics

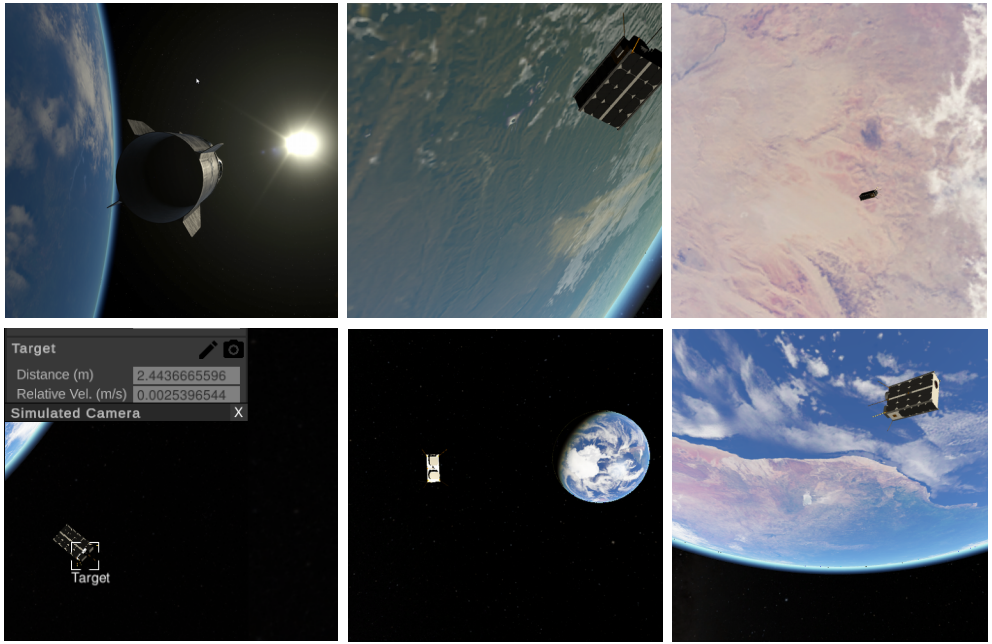
Multiple objects simulated in real-time (video)



Training DL models

Synthetic data generation for training and testing CV and DL implementations

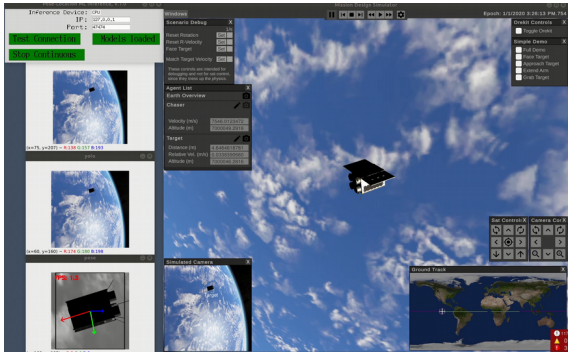
- Representative environment
- Dynamic lighting effects with modeled optics
- Labeled datasets
- Real-time inference for testing the developed models
- Ray tracing implementation (in-progress)



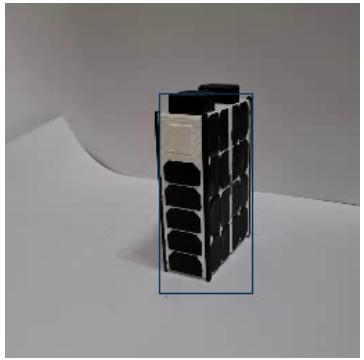
MDS “Baker” generated image sets

Development pipeline

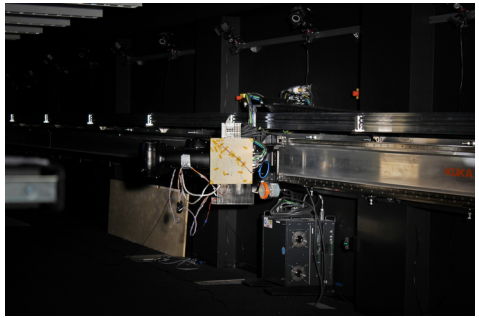
Models for satellite detection, pose estimation and robotics algorithms

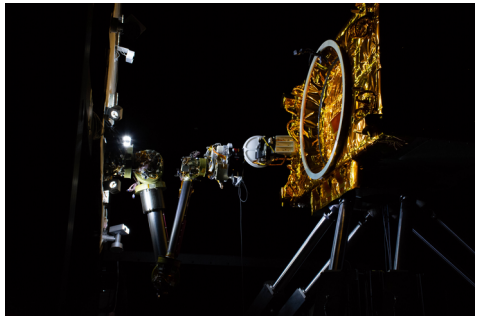


Training and inference tests in simulation (video)



Inference in physical world with scaled models (video)





End-to-end laboratory testing

Current limitations

Moving beyond prototyping and closing the domain gap

- Lighting environment in space
- 3D and physics models including optics modeling
- All libraries used to write flight code must be real-time compatible

ATV docking with ISS (real image)

Future work

Verification, validation, further integration to support new and upcoming IOS missions

- Verify and validate DL models for critical applications
- Obtain image-sets from space to improve simulation
- Test with space rated hardware that can run DL
- Validation of key elements through IOD/IOV mission in 2023

ClearSpace-1 mission

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Building autonomy in space

Project co-funded by esa

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Disclaimer: The view expressed herein can in no way be taken to reflect the official opinion of the European Space Agency.

Thank you !

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