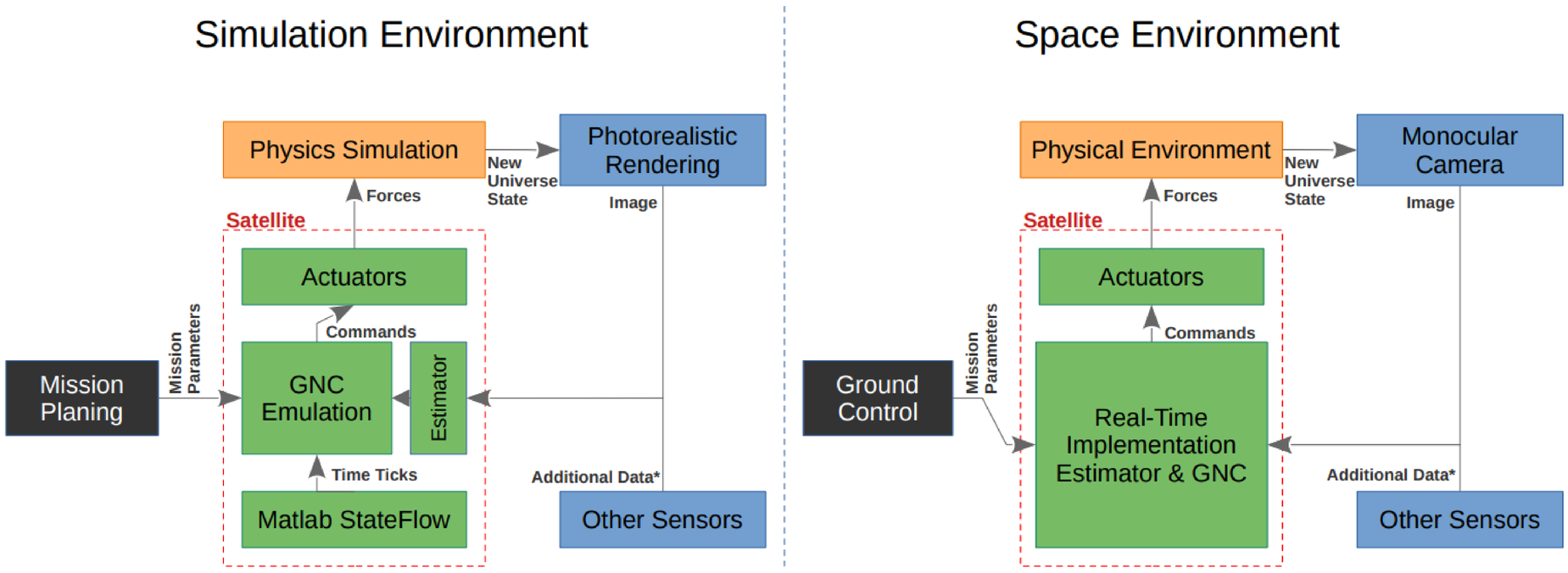
HSLU Hochschule Luzern

Technik & Architektur
Elektrotechink

Master Thesis Electrical Engineering

Space Mission Explorer (SME)

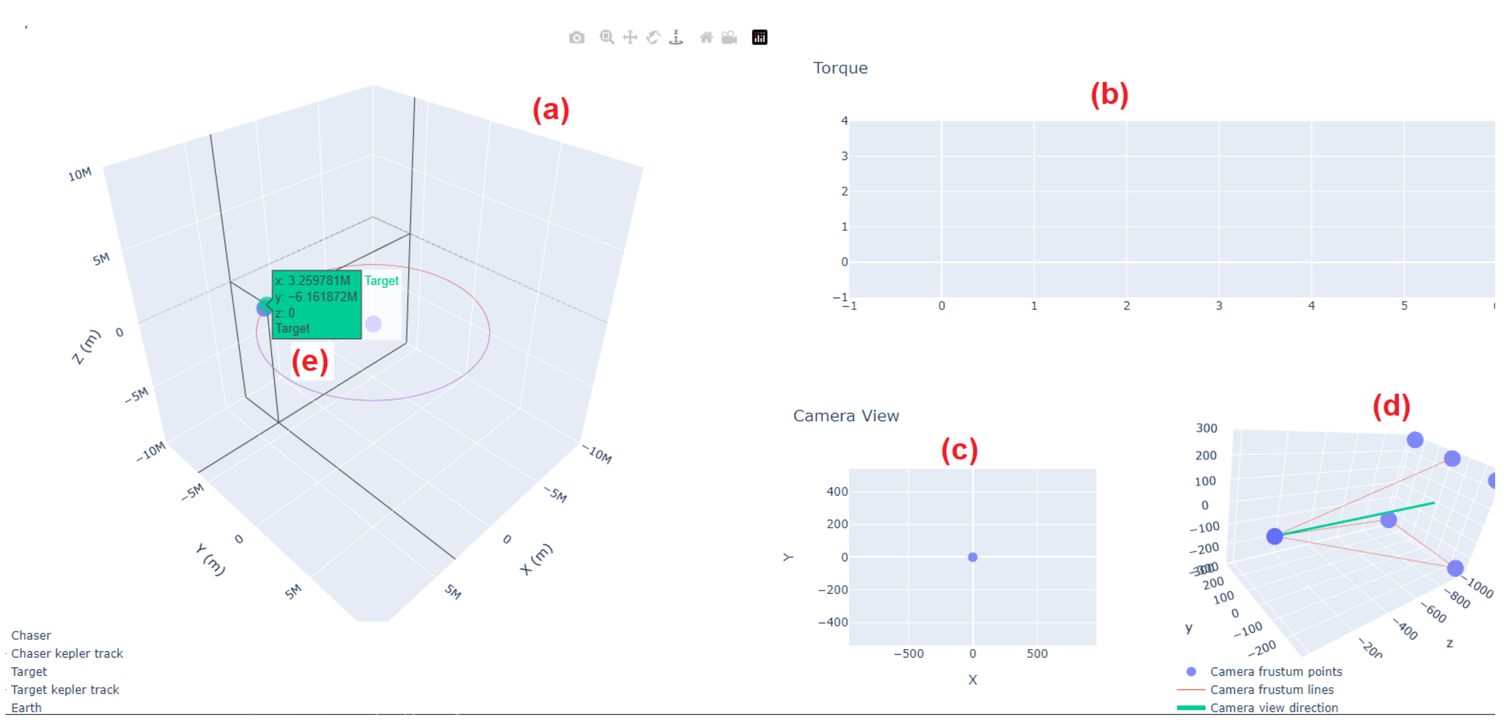
A Simulation Environment for Vision-Based Active Space Debris Removal



* *IMU, lidar, radar, GPS, ...*

Conceptual block diagram, showing the components of the Simulation Environment compared to the real world.

Rendered Images from the Blender Pipeline



GUI available to the Mission Engineer to monitor a simulated mission.

In recent years, the problem of space debris gains more importance, as more and more objects orbit earth. In a wors-case scenario, this could lead to immense problems on a global scale, as communication and global navigation is heavily dependent on satellite systems.

HSLU is part of a project that would like to tackle this problem, by developing a spacecraft that can autonomously approach and dock to a non-cooperative spacecraft. The final approach is envisioned to use a camera system in order to estimate the pose of the target spacecraft. Using this information, the chaser spacecraft shall plan its maneuvers in order to successfully fulfill its mission.

This work focuses on enabling a prove of concept of such missions using a closed-loop simulation environment.

The solution consists of a closed-loop simulation environment, including photo-realistic rendering, timing analysis and physics simulation (see top figure). The simulator enables a mission engineer to validate a mission in many aspects. The most important unique feature of this simulator would be the photo-realistic rendering in order to allow validation of vision-based pose estimation algorithms.

The initial goal was achieved and a closed-loop simulation environment was created. As envisioned, it allows evaluation and simulation of missions with vision algorithms in-the-loop. The figures above show two parts of the simulator. Bottom left shows the high degree of photo-realism that the rendering pipeline provides, while the bottom right shows the real-time web-based mission monitoring GUI, that updates satellite states and visualizes the mission as it is simulated.

In addition to that, an example mission was designed in order to show the benefits of the developed tool as well as showing that a vision-based space debris removal mission was indeed achievable. This work was able to show that this is the case.

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