Modeling, Design and Operation of Robotic Tether-Net Systems for Reliable Capture of Targets

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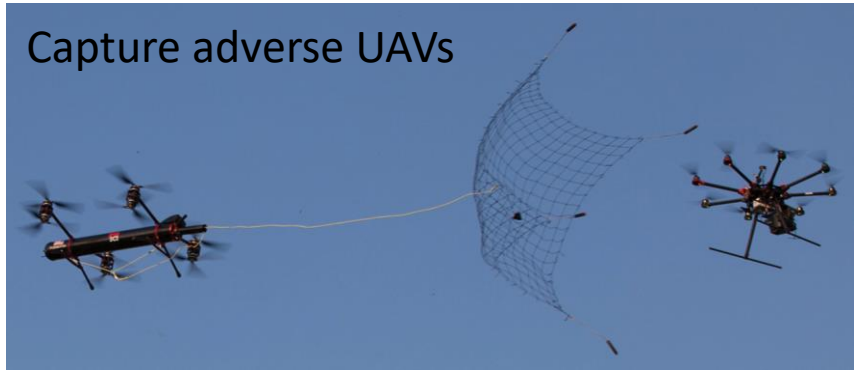
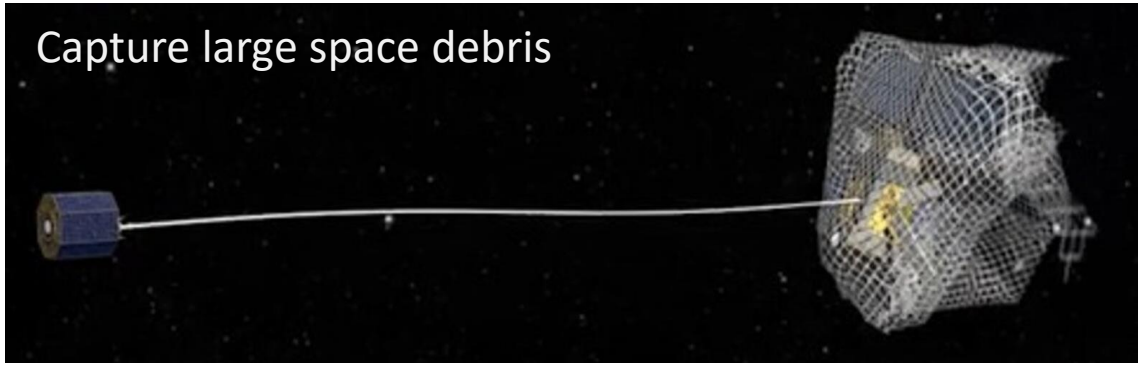
Challenge

Advance our scientific understanding of how to autonomously capture flying target objects using robotic tether-net systems that can be launched from a chaser vehicle such as an unmanned aircraft or spacecraft.





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Solution Approach

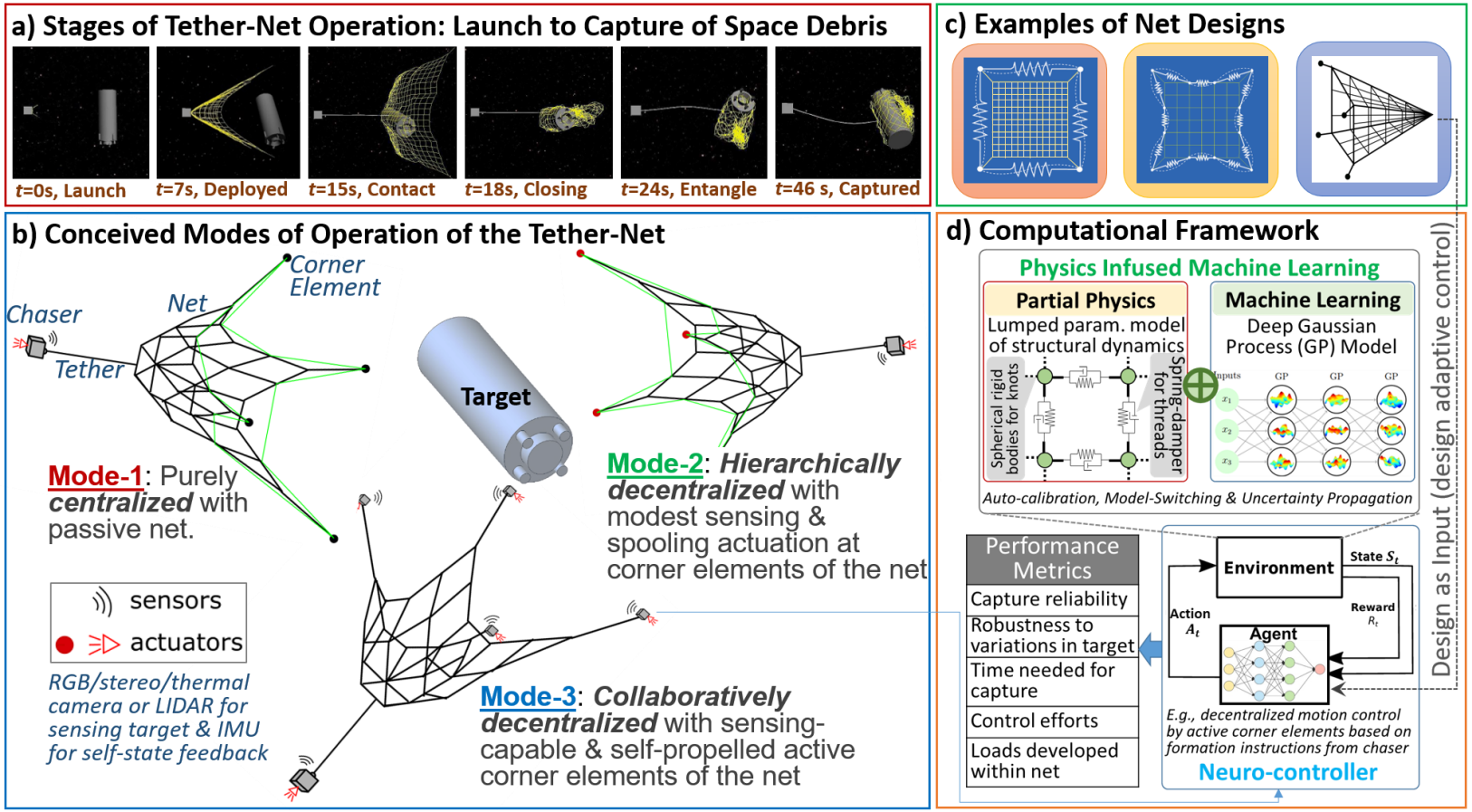
Synergizing net dynamics and contact mechanics, engineering optimization and machine learning to enable robust design and autonomy.

Intellectual Merit

Physics-infused machine learning to auto-calibrate net dynamics and contact models with cost/fidelity trade-offs suitable for learning and deploying controllers.

Compare and contrast centralized control and novel (decentralized) formation control approaches to regulate net launch, maneuver and closure.

Reliability-based optimization with design-adaptive neuro-control to identify optimal net designs.



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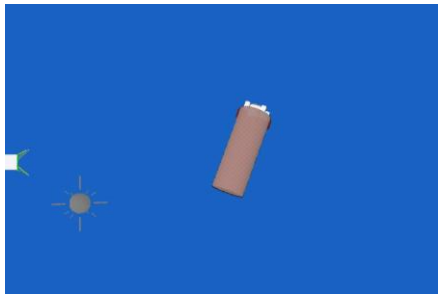
New Contributions

Optimized Design
(lighter, more reliable)

Total Mass: **6.6kg** Success Rate: **100%** Capture Time: **25s**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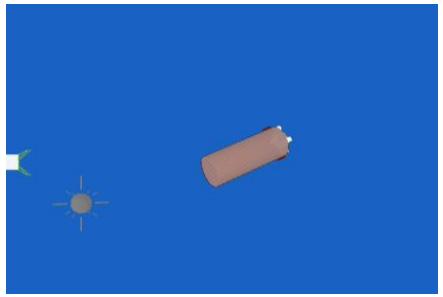
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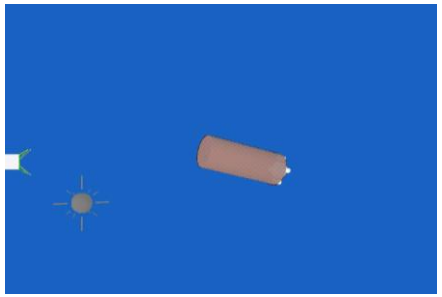
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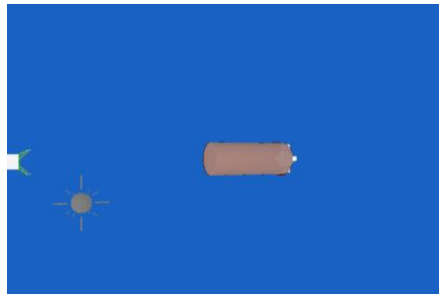
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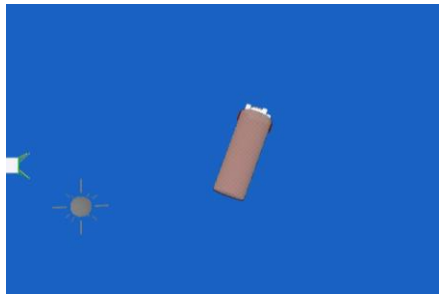
Baseline
(low reliability with uncertainty)

Total Mass: **55kg** Success Rate: **75%** Capture Time: **35s**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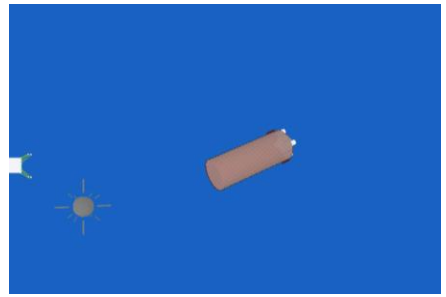
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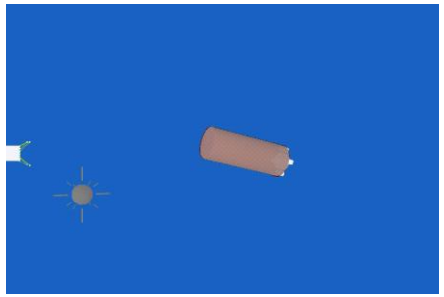
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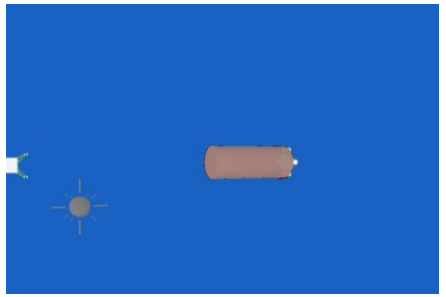
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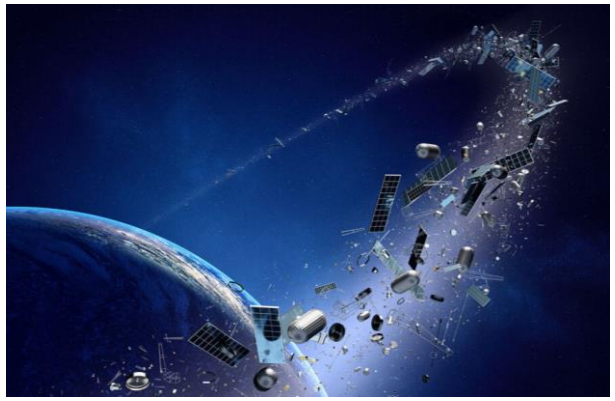
Broader Impact

Use-case of space debris removal: continued safe exploitation of commercial orbits.

- Benefit satellite operators, U.S. national agencies, the public who rely on earth observation satellites
- Help strengthen U.S. leadership in Space.



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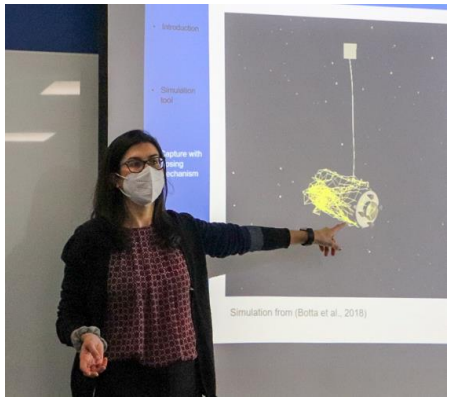

Broaden participation of women in STEM, particularly robotics, through hands-on robotics experiences.

Promote exposure of engineering students to the emerging technology of net-based robotics.

Release first-of-their-kind open-source OpenAI benchmarks and ROS libraries on tether net systems (reducing barriers to entry to research).