Autonomous Maneuvering within Chaotic Multi-Body Systems

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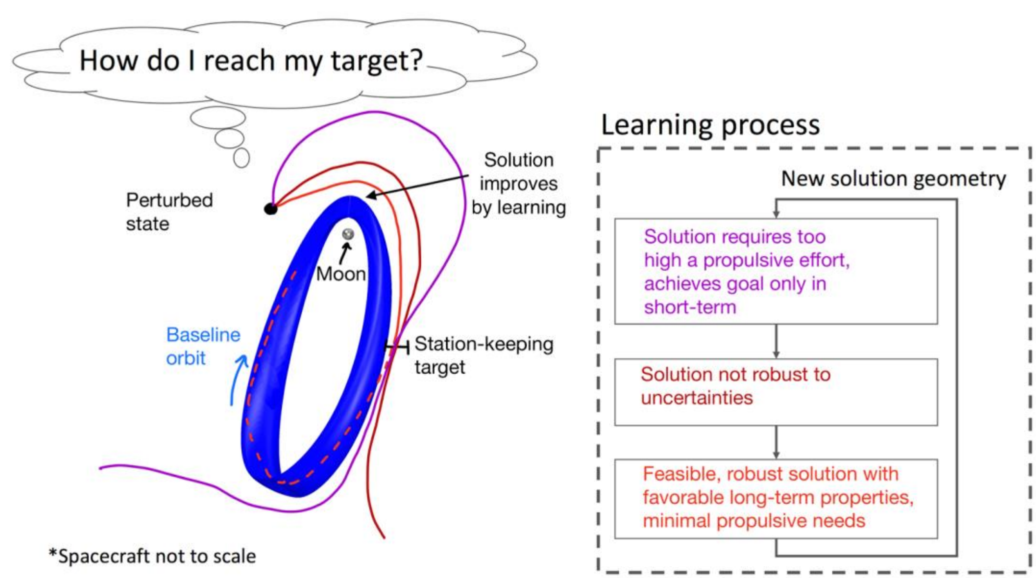
Technology transition plan facilitated by industry:
Advanced Space LLC
Orbit Logic

Research Objectives:

1) Offline learning for feasible, efficient maneuvers
2) Online learning for robustness and resiliency
3) Autonomous introspection and machine self-confidence

SOA: Current maneuver planning approaches rely heavily on human-in-the-loop for design and verification
Innovation: 1) Incorporating machine learning into maneuver planning process, 2) advancing machine learning to handle chaos and self-adapt

TRLs: Autonomous onboard maneuver planning raised from TRL 1 to TRL 2 via development of RL algorithms and study of feasibility.



Algorithms will be developed to learn to plan robust, efficient maneuvers in uncertain and chaotic environments

Approach:

Objective 1:

- Use inverse reinforcement learning to recover behavior of human maneuver planner who can learn and adapt
- Use reinforcement learning (RL) to design efficient and safe maneuvers that achieve station-keeping/reconfiguration goals

Objective 2:

- Update RL algorithm to learn to detect off-nominal events, plan under uncertainty, schedule coast/maneuver segments flexibly

Objective 3:

- Develop principled process-driven framework for machine self-confidence to report and adapt learning competency

Potential Impact:

Result: Development of new technology that will enable autonomous onboard maneuver planning in-orbit
Benefits:

- Enhances variety of missions by reducing operational cost and complexity
- Enables missions that require rapid response without human-in-the-loop (e.g. those with communication delay)
- Support resiliency of spacecraft in unexpected challenges or uncertain environments