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Cooperative Rendezvous in Multi-vehicle Systems

By: Rajeev Shobhit Voleti

Thesis advisor: Dr. Kamesh Subbarao

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Abstract

The rapid expansion and evolution of cooperative, multi-vehicle systems have revealed considerable potential for enhanced autonomy, resilience, and robustness. Yet, they are fraught with complexities related to maintaining secure and efficient rendezvous between peers. In the context of cooperative control, "rendezvous" is understood as the simultaneous convergence of multi-vehicle systems to a target location. Current methodologies struggle with synchronization challenges and high latency which can significantly degrade the system's performance and reliability. Furthermore, conventional consensus protocols are often insufficient in mitigating threats in such environments, leaving the system vulnerable to various attacks. Hence, there is an exigent need for robust, innovative solutions.

Addressing these issues, our research proposes an innovative solution: the orchestration of multi-vehicle secure rendezvous in finite time through a network-shared time-to-go.

We frame the secure rendezvous problem within a traditional multiple missile target engagement or "salvo" scenario, proposing the lateral accelerations of pursuer missiles to be determined by a finite time, time-dependent guidance law using a max time-to-go consensus protocol. This concept will be illustrated via a range of simulation scenarios. Once the consensus and convergence framework is established, we will explore its implementation on a decentralized network of agents to derive the necessary conditions for rendezvous. Our ultimate goal is to provide an optimal solution to the secure rendezvous problem using a collocation-based control optimization scheme, with the potential for extending the rendezvous framework to accommodate higher-order, centralized, objective-based requirements.