(2025–…)

PoC Case Study:

Navigation for a High-Inertia Controlled Object in a Lyapunov-Like State Space

Context and motivation

This project is a proof of concept for a navigation and positioning approach designed for a controlled object with pronounced inertial behavior. The core assumption is that the object operates in a state space that can be interpreted in a Lyapunov-like manner: the space naturally contains regions that correspond to stable behavior as well as regions near unstable equilibrium. The practical difficulty is not “getting to a point” in the classical sense, but achieving reliable positioning when the dynamics are dominated by inertia, delays, disturbances, and uncertainty in state estimation.

Goal

The primary objective of the PoC is to validate positioning and controlled holding within the neighborhood of an unstable equilibrium. In such a regime, small deviations may grow quickly, and the system must continuously compensate for drift while respecting actuator limits and timing constraints. The PoC therefore treats real-time discipline as part of the physics of the system: the quality of positioning depends not only on the control law itself, but also on bounded latency, jitter, and repeatability of the control cycle.

Implementation as a test stand

The PoC was implemented as an engineering test stand that combines the computational control core, a sensing loop for state estimation, a controlled actuation layer, and an experiment environment that supports reproducible scenarios. The stand provides structured instrumentation for logging and replay, allowing systematic comparison across configurations and enabling fast iteration on the navigation and stabilization logic. The implementation emphasizes clarity of interfaces and modularity, so that algorithms can be refined without rebuilding the entire system.

Outcome and deployment

As a result, the PoC demonstrated controlled positioning behavior in the targeted unstable-equilibrium area under stand conditions, and produced a baseline architecture and a set of engineering artifacts suitable for further scaling. Elements of this work were subsequently adapted and integrated into systems covered by NDA; therefore, the publicly shared description remains intentionally high-level and focuses on the technical intent, boundaries, and outcomes rather than internal design details.