

# Research Project 1 - Target Interception with Time Varying Acceleration Constraints

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This project reproduces the guidance law of Nahum and Shaferman, **Optimal Ground-to-Air Interception with Time-Varying Acceleration Bounds** [1]. We re-derive the law, implement it, and validate it in simulation, obtaining results that closely match those reported in the paper. The guidance law addresses ground-to-air interception with explicit, time-varying lateral-acceleration limits that decrease with altitude due to reduced air density. It is derived from a linear quadratic optimal control formulation with a hard acceleration constraint, and the formulation assumes linear missile dynamics of zero or first order, with linear target dynamics of arbitrary order. The law is evaluated in a nonlinear simulation and compared against an unbounded classical optimal guidance law. Across challenging scenarios, explicitly modeling saturation improves performance and increases interception success, primarily because the controller anticipates future limits and initiates stronger maneuvers earlier, while higher acceleration is still available.

## References

- [1] Nahum, O., and Shaferman, V., “Optimal Target Interception with Time-Varying Acceleration Constraints,” *AIAA SCITECH 2024 Forum*, American Institute of Aeronautics and Astronautics, Orlando, FL, 2024. <https://doi.org/10.2514/6.2024-1986>, URL <https://arc.aiaa.org/doi/10.2514/6.2024-1986>.

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