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OPTIMAL GUIDANCE AND CONTROL OF LAUNCH VEHICLES AND BALLISTIC MISSILES

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ABSTRACT

This study deals with the guidance and control of ballistic missiles and launch vehicles. We started by formulating this guidance problem as a trajectory optimization problem. This is a nonlinear optimal control problem with constraints on the final states and control variables. The fixed final constraints are treated as terminal penalties . We discussed several methods as they apply to optimal control in order to point out their limitations and compare them. We have presented first and second Differential Dynamic Programming (DDP) algorithms resulting from first and second order expansion of the value function respectively. Jarmark algorithm was taken as a candidate for first order algorithm. It showed good monotonic iterative convergence and it is relatively simple for real time implementation. Second order methods provides a feedback control law. However they are very complex and inadequate for on line implementation specially for short range trajectories.
DDP algorithms showed to be more efficient and more general than the shooting point method, implemented on most developed guidance algorithms, in defining the correction procedure for the miss in end conditions. Nonlinear programming algorithms provide systematic approach but its convergence is highly dependent upon the assumed initial time history of the control variables.
Singular Perturbation Theory (SPT) does not simplify too much the problem because we still have to solve Two Point Boundary Value Problems (TPBVP).

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