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# New Optimal-Control-Based Techniques for Midcou...

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2 (ABSTRACT) The following is an exploration into the optimal guidance and control of gun-launched guided projectiles. Unlike their early counterparts, modern-day gun-launched projectiles are capable of considerable accuracy. This ability is enabled through the use of control surfaces, such as fins or wings, which allow the projectile to maneuver towards a target. These aerodynamic features are part of a control system which lets the projectile achieve some effect at the target. With the advent of very high velocity guns, such as the Navy's electromagnetic railgun, these systems are a necessary part of the projectile design. This research focuses on a control scheme that uses the projectile's angle of attack as the single control in the development of an optimal control methodology that maximizes impact velocity, which is directly related to the amount of damage inflicted on the target. This novel approach, which utilizes a reference trajectory as a seed for an iterative optimization scheme, results in an optimal control history for a projectile. The investigation is geared towards examining how poor an approximation of the true optimal solution that reference trajectory can be and still lead to the determination of an optimal control history. Several different types of trajectories are examined for their applicability as a reference trajectory. Although the use of aerodynamic control surfaces enables control of the projectile, there is a potential down side. With steady development of guns with longer ranges and higher launch velocities, it becomes increasingly likely that a projectile will fly into a region of the atmosphere (and beyond) in which there is not sufficient airflow over the control surfaces to maintain projectile control. This research is extended to include a minimum dynamic pressure constraint in the problem; the imposition of such a constraint is not examined in the literature. Several methods of adding the constraint are discussed and a number of cases with varying dynamic pressure limits are evaluated. As a result of this research, a robust methodology exists to quickly obtain an optimal control history, with or without constraints, based on a rough reference trajectory as

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