Sensitivity Methods Applied to Orbital Pursuit-Evasion  
Doctoral Dissertation Defense  

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Abstract  

In this work, sensitivity methods are examined as a means to solve and analyze the problem of orbital pursuit-evasion (PE). Orbital PE is a two-sided spacecraft trajectory optimization problem characterized by high dimensionality and nonlinearity. Modern methods for solving problems of this sort employ generic, computationally intensive techniques, including random search methods such as the genetic algorithm; collocation methods based on discrete approximation; or combinations of these methods. The advantages of these methods are relatively high degrees of robustness, straight-forward implementation, and ease of handling state and control constraints. Yet we note the disadvantages: chiefly high computation load, as well as absence of insight into the problem, and accuracy of the result. Sensitivity methods provide corresponding strengths in each of these areas. We present novel sensitivity analysis techniques applicable to orbital PE, including: a computationally efficient feedback control technique; a means of sketching barrier surfaces; and the use of hybrid one-sided/two-sided controllers for sophisticated emergent behavior. We also introduce a new formulation of the problem incorporating a minimum-altitude constraint. Our results suggest that sensitivity methods can provide useful augmentation to techniques that rely more heavily upon computational power.

Will Hafer is a PHD candidate in the Aerospace Engineering Department working under the supervision of Professor Helen Reed. His research interests are in the areas of spacecraft trajectory optimization and applied differential game controllers. His future plans remain a run-time decision at present, but he is interested in any opportunity to contribute to the profession and put his GN&C skills to good use.