5-DOF Simulations for Parametric Assessment of Missile Engagement Envelope

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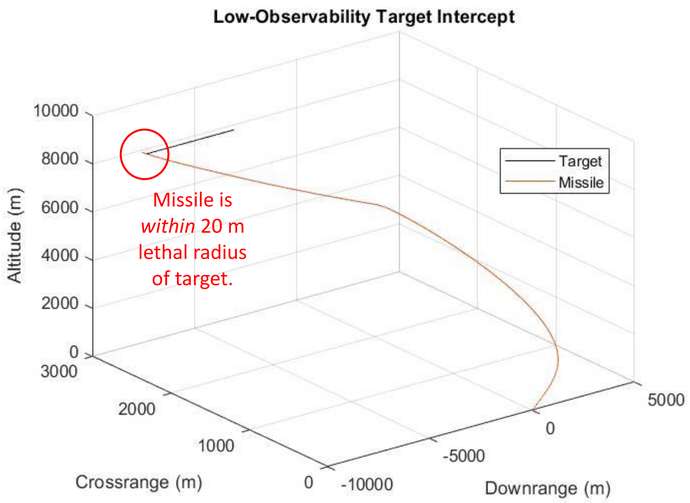
Objective

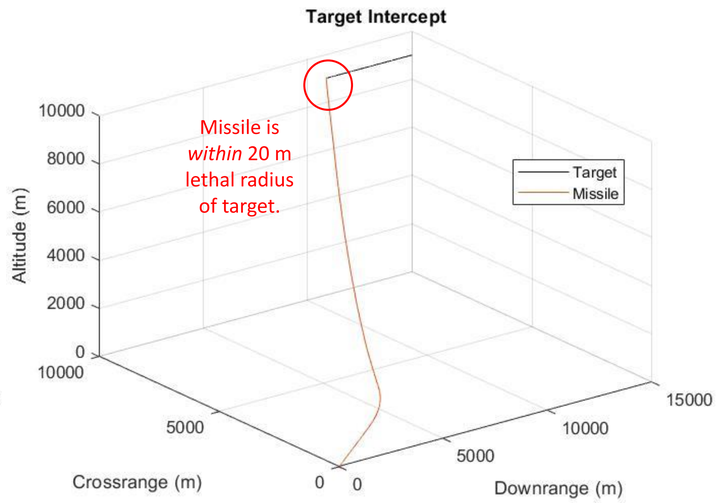
This research determined the engagement limits of a generic but realistic surface-to-air missile (SAM) through five degree-of-freedom (5-DOF) simulations.

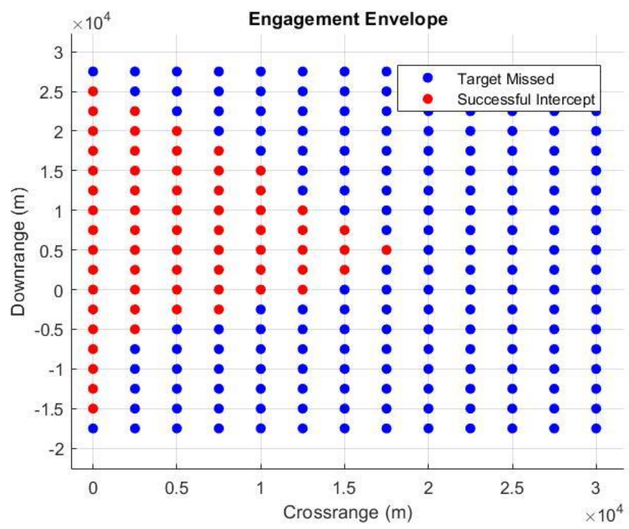
Method

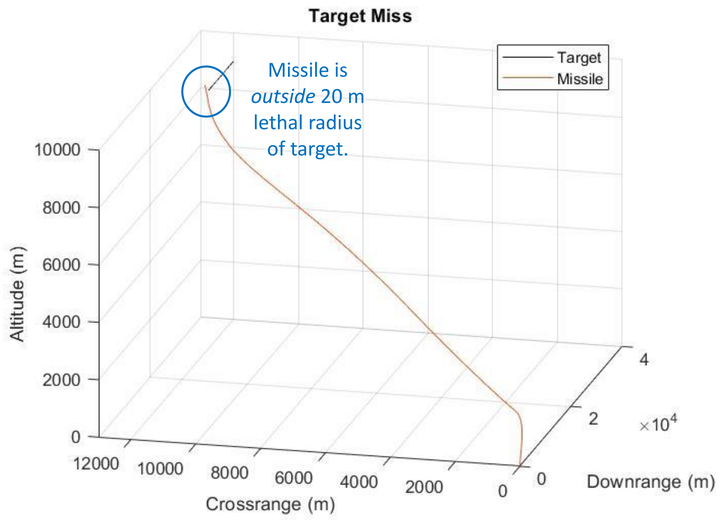
The SAM equations of motion were derived based on rigid-body dynamics and Euler angles which were integrated for using a 4-th order Runge-Kutta method. The missile control algorithm was formulated around an elementary form of proportional navigation guidance laws which alters the missile velocity angle through tail fin deflection rates while predicting an intercept location. Detection locations were varied over a grid of downrange and crossrange coordinates for a cruising target flying at low supersonic speed.

Example Simulations and Results









Conclusion

Code was developed which can integrate the equations of motion of a missile while implementing a live-time control algorithm to engage a moving target. The successful intercepts were mapped over the detection location grid to determine the engagement envelope of a realistic surface-to-air missile.

Discussion and Future Work

The engagement envelope border was found to be most limited by the efficiency of the control algorithm and tail fin parameters. In order to further characterize the engagement envelope, the missile and target parameters, such as lethal radius or target speed, could be systematically explored. Furthermore, the target could be given a defensive maneuver algorithm based upon the approaching SAM.

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