A New Guidance Law With Impact Angle Constraint

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The problem: Guidance with Impact Angle Constraints:
The problem I examined for my Thesis was guidance with an impact angle constraint. That is, to come up with some control law which will guide a vehicle to a specific target from some predefined approach angle. This is useful for areas such as missile guidance and spacecraft control.

A New Law: Angle Matching Guidance:

Guidance Law:
The idea is to guide the vehicle on a circular arc to the target.

There is a unique circle defined by the following factors:
• The missile’s initial position is on the circle
• The target’s position is on the circle
• The desired impact direction is a tangent to the circle at the target’s position.

Consider the situation of missile guidance in the figure below. The desired final impact direction is Z. It was found that the missile can be guided along the circular path to impact with exactly the right angle if line of sight angle (lambda) is always equal to the angle between the line of sight and the desired impact direction (epsilon). This is the origin of the term “Angle Matching Guidance”

Simulation Results:
The first set of simulations done compared Angle Matching Guidance (AMG) to an existing guidance law, Biased Proportional Navigation Guidance (BPNG).

Overall, AMG was found to perform much better. Shown below is an example plot of the error in impact angle, over a range of desired impact angles relative to the target’s heading. For example, a desire impact angle of 0 degrees is a tail-on collision, and 180 degrees is head-on.

Output Feedback: The Robust Kalman Filter

Also considered was the case where it is not possible to measure the entire state (all the positions and velocities involved) and an estimation must be made based on partial measurements corrupted by noise.

To do this we need a state estimator, also known as an observer. Two types where considered: The standard Kalman filter, and the robust Kalman filter. The latter was found to give better results.