Introduction to Navigation & Guidance

(Course Code: AE 410/641)

Department of Aerospace Engineering
Indian Institute of Technology Bombay

Tutorial - 4

Instructor: Shashi Ranjan Kumar

November 12, 2020

1. Consider the engagement geometry shown in Figure 1 where symbols have their usual meanings. If the target is stationary and the interceptor is guided using parallel navigation, the engagement kinematics is governed by

$$\dot{r} = -V\cos\sigma, \tag{1a}$$
$$r\dot{\theta} = -V\sin\sigma, \tag{1b}$$
$$\dot{\gamma} = N\dot{\theta}, \tag{1c}$$
$$\gamma = \theta + \sigma. \tag{1d}$$

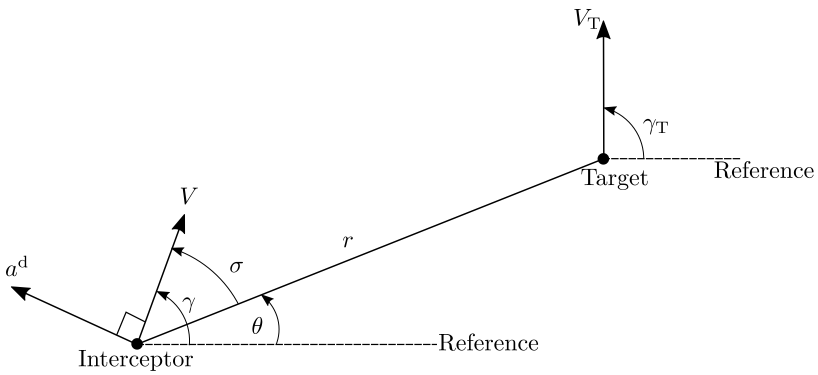

Figure 1: Interceptor-target planar engagement geometry.

(a) Prove that the angle of arrival (the angle at which the interceptor captures the target) is given by

$$\theta_f = \theta_0 - \frac{\sigma_0}{N-1}.$$

(b) Prove that the interceptor's lateral acceleration, a^d, is given by the expression

$$a^d = \frac{NV^2\sin\sigma_0}{r_0}\left(\frac{r}{r_0}\right)^{N-2},$$

where $\theta_0 \triangleq 0$, r_0, and σ_0 are initial values of the corresponding variables.

(c) What happens to a^d for various values of N?

2. Consider a modified parallel navigation law, defined as $\dot{\gamma} = \dfrac{K r \dot{\theta}}{\cos \sigma}$, where $K > 0$, against a non-maneuvering target. Prove that as the term $r^2 \dot{\theta} \to 0$ as $t \to \infty$.

   Hint: *Reasonably assume* $\gamma_{\mathrm{T}} = 0$ *since the target does not maneuver.*