Guidance methods

Method#01 – Zero-bearing guidance method

Initial state of the distance between a vehicle#1 and a vehicle#2

$$r_0 = \sqrt{(Y_{C0} - Y_0)^2 + (X_{C0} - X_0)^2}. \tag{1.01}$$

Initial state of the sight angle

$$\varphi_0 = arctg\left(\frac{Y_{C0} - Y_0}{X_{C0} - X_0}\right). \tag{1.02}$$

Kinematic equations of the center of mass motion

$$\begin{aligned} \frac{dr}{dt} &= V_C \cos(\varphi - \theta_C) - V \cos(\varphi - \theta), \\ r\frac{d\varphi}{dt} &= -V_C \sin(\varphi - \theta_C) + V \sin(\varphi - \theta). \end{aligned} \tag{1.03}$$

Dynamic equations of angular motion

$$\begin{aligned} \frac{d\theta}{dt} &= \frac{P + C_Y^{\alpha} S \rho(H) V^2 / 2}{mV}\alpha, \\ \alpha &= \varphi - \theta, \end{aligned} \tag{1.04}$$

where φ is a sight angle.

Equation for a calculation of ideal constraint

$$\varepsilon = \varphi^* - \varphi = 0. \tag{1.05}$$

Equations for a calculation of vehicles coordinates

$$\begin{aligned} \frac{dX}{dt} &= \frac{dL}{dt} = V\cos\theta, \quad \frac{dX_C}{dt} = \frac{dL_C}{dt} = V_C \cos\theta_C, \\ \frac{dY}{dt} &= \frac{dH}{dt} = V\sin\theta, \quad \frac{dY_C}{dt} = \frac{dH_C}{dt} = V_C \sin\theta_C. \end{aligned} \tag{1.06}$$

Equation for a calculation of a g-force

$$n_y = \frac{V}{g}\dot{\theta} + \cos\theta \tag{1.07}$$

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Method#02 – Fixed lead angle guidance method

…coming soon…

Case study - Input data

Vehicle#1	Vehicle#2
$V = 630\ (m/s)$	$V_C = 300\ (m/s)$
$X_0 = 0\ (m)$, $Y_0 = 15000\ (m)$	$X_{c0} = 12000\ (m)$
$S = 0.3\ (m^2)$, $m = 350\ (kg)$	$Y_C = 9000\ (m)$
$P = 5250\ (N)$, $C_y^{\alpha} = 4$	$\theta_C = -115\ (grad)$

Case study - Simulation results

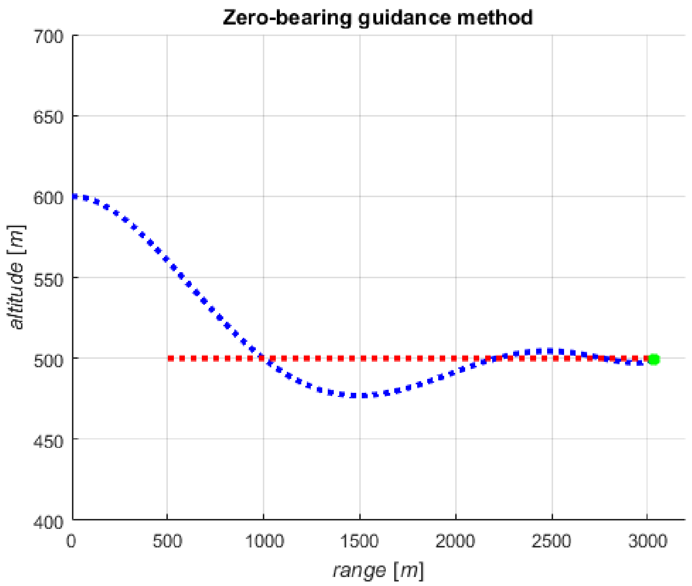

Figure 1.01 Docking trajectory (method#1)

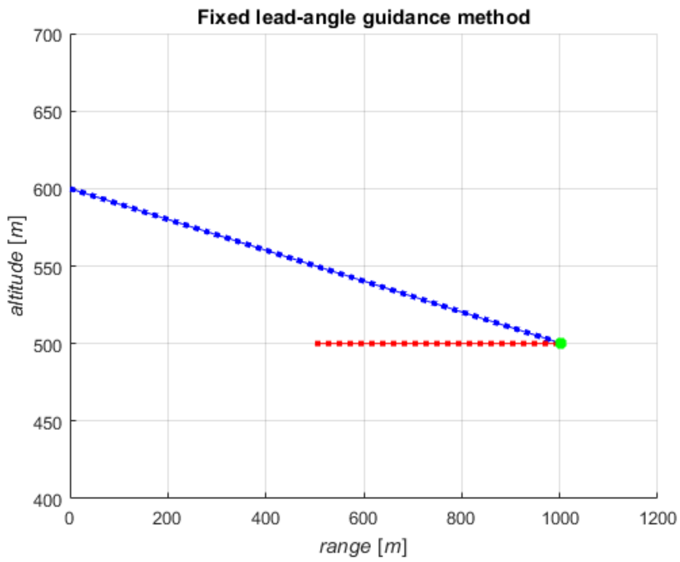

Figure 2.01 Docking trajectory (method#2)

References

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