ELEC 3224 — Guidance Laws

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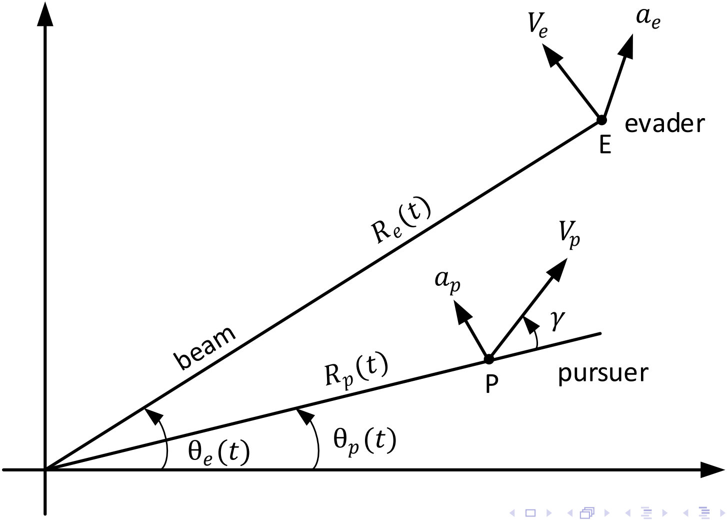
Beam Rider (BR) and CLOS

- The principle of this form of guidance law is that **the pursuer should fly or travel along the beam trained on the evader from a ground tracker.**
- The beam should continuously track the target.
- Pursuer commands are a function of the angular deviation from the beam — assuming zero beam width.

Beam Rider — Geometry



Beam Rider

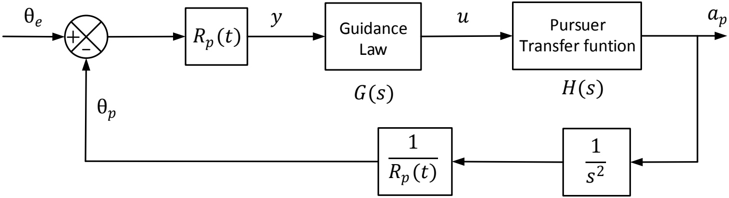
- Distance of the pursuer from the beam is

$$y = R_p(\Theta_e - \Theta_p)$$

  and the objective is to minimise $y(t_f)$.
- For a non-manoeuvring target, PN is a straight line and BR is a curve.
- Next an analysis is given for a unit transfer-function system.
- Linearised model

$$u = KR_p(\Theta_e - \Theta_p) = Ky$$

Beam Rider — Geometry



Beam Rider

- r_p is time-varying but for basic analysis it can be taken as constant.
- If $G(s) = K$ and $H(s) = 1$ then

$$\frac{a_p(s)}{\Theta_e(s)} = \frac{KR_p s^2}{s^2 + K}$$

- This transfer-function has poles at

$$s = \pm j\sqrt{K}$$

- This is simple harmonic motion and is not an acceptable design.

Beam Rider

- Try a controller of the structure

$$G(s) = 10\frac{(1+\frac{s}{2})}{(1+\frac{s}{20})}$$

i.e., a phase-lead controller.

- Then in this case, the closed-loop poles are given by

$$\frac{s^3}{20} + s^2 + 5s + 10 = 0$$

- This case can be **stable or unstable.**
- In general, PN navigation yields smaller miss distance and lower acceleration requirements than BR guidance.

CLOS

- Engagement geometry as with BR.
- Now modify the BR law to include beam motion.
- From before

$$\ddot{r} = (\ddot{r} - r\dot{\Theta}^2)e^{j\Theta} + je^{j\Theta}(2\dot{r}\dot{\Theta} + r\ddot{\Theta})$$

- Hence the acceleration **normal to the vector** is $2\dot{r}\dot{\Theta} + r\ddot{\Theta}$.
- In this case, **the pursuer is to stay on the beam.**

CLOS

- In this case it is required that $\Theta_p = \Theta_e$ **and also**

$$\dot{\Theta}_p = \dot{\Theta}_e$$

- and

$$\ddot{\Theta}_p = \ddot{\Theta}_e$$