Controller design

CSG [1],

1 Control problem with moving targets

Two optimal control problems of approaching and aiming with moving targets are under consideration.

Let $T = [t_*, t^*]$ be the control interval.

Object of control:

$$\dot{x} = A(t)x + b(t)u + M(t)w, t \in T; x(t_*) = x_0 \tag{1}$$

and moving target:

$$\dot{\tilde{x}} = \tilde{A}(t)\tilde{x} + \tilde{b}(t)v + \tilde{M}(t)w, t \in T; \tilde{x}(t_*) = \tilde{x}_0 \tag{2}$$

Here

$x = x(t) \in \mathbb{R}^n, \tilde{x} = \tilde{x}(t) \in \mathbb{R}^n$ are the state of control object and state of the target.

$u = u(t) \in \mathbb{R}$ - control input; $v = v(t) \in \mathbb{R}$ - maneuvering effort of target; $w = w(t) \in \mathbb{R}^{n_w}$ - disturbances.

If $\tilde{b}(t) = 0, t \in T$ then target is *not maneuvering*, otherwise it is *maneuvering target.*

Admissible discrete control function:

$$u(\cdot) = (u(t) \in U, t \in T)$$

Unknown maneuvering efforts $v(t), t \in T$ and disturbances $w(t), t \in T$ represented in the following form:

$$v(t) = v_1(t) + v_2(t),\ w(t) = w_1(t) + w_2(t),\ t \in T$$

where

$$v_1(t) = K_v(t)v, v \in V_1;\ w_1(t) = K_w(t)w, w \in W_1, t \in T$$

- regular components,

$$v_2(t) \in V_2;\ w_2(t) \in W_2, t \in T$$

not regular components $(V_1, W_1, V_2, W_2; K_v(t), K_w(t), t \in T)$ - are known; $v, w; v_2(t), w_2(t), t \in T$ - are arbitrary.

In case,when $M(t) = 0, \tilde{M}(t) = 0, \tilde{b}(t) = 0, t \in T; x_0, \tilde{x}_0$ are fixed vectors, the models (1)-(2) *deterministic*,otherwise *indeterministic*.

Also let $X_\rho(\tilde{x}) = \{x \in \mathbb{R}^n : \rho g_* \leq H(x - \tilde{x}) \leq \rho g^*\}$ - ρ-neighborhood of a point $\tilde{x}$, where

$$H \in \mathbb{R}^{m \times n}; g_*, g^* \in \mathbb{R}^m, -\infty < g_* < 0 < g^* < \infty; \rho \geq 0.$$

The problem of optimal approaching consist in the way of choosing $u^0(\cdot)$,such that (1) at final moment t^* will be at the set $X_{\rho^0(\tilde{x}(t^*))}$ with minimal ρ^0.

The problem of aiming- to be on $X^* = X_1(\tilde{x}(t^*))$ with minimal $J(u) = \int\limits_{t_*}^{t^*} |u(t)|dt$.

For the problems above can be investigated the following situations:

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- Deterministic problem statement;
- Maneuvering target;
- Not maneuvering target with noncompletely defined motion, imperfect measuring;
- Maneuvering target,imperfect measuring;
- Indeterministic models, imperfect measuring.