THE PROBLEM "BOY AND CROCODILE" WITH TIME-LAG

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We consider the analog of pursuit problem in the case when dynamics of the game is described by the following system of differential-difference equations:

$$\dot{z}_1(t) = z_2(t-\tau) - v, \qquad z_1 \in \mathrm{R}^n, \ n \ge 2,$$

$$\dot{z}_2(t) = u, \qquad z_2 \in \mathrm{R}^n,$$

$$\|u\| \le \rho, \ \rho > 0, \|v\| \le \sigma, \sigma > 0.$$

The pursuer ("crocodile", *u*) is clumsy because of the boundness of his trajectory curvature radius though he may gather a high speed. The evader ("boy", *v*) is inertia-less though his speed is limited.

The terminal set is $M^* = \{z = (z_1, z_2) \in \mathrm{R}^{2n} : \|z_1\| \le l\}$. Matrix function $K(t)$ is unique and enjoys the properties: $K(t) = 0,\ t < 0$; $K(0) = E_{2n}$; $K(t)$ is continuous on $[0, +\infty)$; when $t > 0$ $K(t)$ satisfies the equation $[\dot{K}(t)] = [B] \cdot [K(t-\tau)], [B] = \begin{bmatrix} 0 & E_n \\ 0 & 0 \end{bmatrix}$.

Using the time-lag exponential $exp_\tau\{B, t\}$ [1], we obtain an explicit form of the fundamental matrix:

$$[K(t)] = \begin{bmatrix} 1 & t \\ 0 & 1 \end{bmatrix} \otimes E_n.$$

For this game the scheme of the method of resolving functions [2] is developed. The guaranteed of the game termination is found, and corresponding control of pursuit is constructed.

References

1. Хусаинов Д.Я., Диблик Й., Ружичкова М. Линейные динамические системы с последействиями. Представление решений, устойчивость, управление, стабилизация. - Киев: ГП Информ.-аналит. агенство, 2015. - 252 с.

2. Chikrii A.A. Conflict-Controlled Processes. - Springer Science & Business Media, 2013.