EVENT-TRIGGERED SLIDING MODE OBSERVER

A. Actuator Side Implementation

Theorem 2: Consider the plant (3) and the observer (10) with the event-triggering mechanism (8). Let $\varepsilon_a > 0$ be any scalar. Suppose that the $(\widetilde{A}_{11}, \widetilde{C}_{11})$ pair is observable. Choose $c_1 > \lambda_{\min}^2(P_1)\varepsilon_a^2/(16\lambda_{\max}(P_1))$ and $c_2 > \varepsilon_a/4$. Assume that $z(0), \hat{z}(0) \in \Omega(c_1, c_2)$, and $z(t)$ is bounded for all $t \geqslant 0$. Moreover, the triggering parameter satisfies the following inequality:

$$\alpha_a < \min\left\{\frac{\varepsilon_a}{2}, \sqrt{\frac{\lambda_{\min}(P_1)}{\lambda_{\max}(P_1)}}\frac{\lambda_{\min}(Q_1)}{\|P_1\widetilde{L}_1\|}\frac{\varepsilon_a}{4\sqrt{2}}\right\}. \tag{12}$$

Then, there exist $K > 0$, $\tau_a > 0$, and $T_a \geqslant 0$ such that

1) the estimation error $\tilde{z}(t) := z(t) - \hat{z}(t)$ is bounded for all $t \geqslant 0$, and moreover, it holds that

$$\|\tilde{z}(t)\| \leqslant \varepsilon_a, \qquad \forall t \geqslant T_a$$

2) $t_{k+1}^y - t_k^y \geqslant \tau_a$ for all $k \in \mathbb{Z}_{\geqslant 0}$.

$$\dot{z}_1 = \widetilde{A}_{11} z_1 + \widetilde{A}_{12} z_2 \tag{3a}$$

$$\dot{z}_2 = \widetilde{A}_{21} z_1 + \widetilde{A}_{22} z_2 + u + d \tag{3b}$$

$$\begin{aligned}\dot{\hat{z}}_1(t) &= \widetilde{A}_{11}\hat{z}_1(t) + \widetilde{A}_{12}\hat{z}_2(t) + L_1\widetilde{C}_{11}\tilde{z}_1(t) + \widetilde{A}_{12}\tilde{z}_2(t) \\ &\quad + L_1\widetilde{C}_{11}e_1(t) + \widetilde{A}_{12}e_2(t) \\ \dot{\hat{z}}_2(t) &= \widetilde{A}_{21}\hat{z}_1(t) + \widetilde{A}_{22}z_2(t) + K\mathrm{sign}\left(\tilde{z}_2(t) + e_2(t)\right) \\ &\quad + u(t) + \widetilde{A}_{22}e_2(t)\,.\end{aligned}$$

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B. Sensor Side Implementation

Sliding mode observer:

$$\begin{aligned}\dot{\hat{z}}_1(t) &= \widetilde{A}_{11}\hat{z}_1(t) + \widetilde{A}_{12}\hat{z}_2(t) + L_1\widetilde{C}_{11}\tilde{z}_1(t) + \widetilde{A}_{12}\tilde{z}_2(t) \\ \dot{\hat{z}}_2(t) &= \widetilde{A}_{21}\hat{z}_1(t) + \widetilde{A}_{22}z_2(t) + u(t_\ell^z) + K\mathrm{sign}\left(\widetilde{z}_2(t)\right).\end{aligned} \quad (13)$$

Theorem 3: Consider the plant (3) and the observer (13). Let $c_1 > 0$ and $c_2 > 0$ be any scalars, and $\alpha_s > 0$ be some given constant. Suppose that the pair $(\widetilde{A}_{11}, \widetilde{C}_{11})$ is observable. Moreover, assume that $z(0), \hat{z}(0) \in \Omega(c_1, c_2)$ and $z(t)$ is bounded for all $t \geqslant 0$. Then, there exist $K > 0$ and $\tau_s > 0$ such that

1) the trajectory $\tilde{z}(t)$ is bounded for all $t \geqslant 0$, and moreover $\tilde{z}(t) \to 0$ as $t \to +\infty$;
2) $t_{\ell+1}^z - t_\ell^z \geqslant \tau_s$ for all $\ell \in \mathbb{Z}_{\geqslant 0}$.

$$t_{\ell+1}^z = \inf\left\{t > t_\ell^z : \|\hat{z}(t_\ell^z) - \hat{z}(t)\| \geqslant \sigma_s\alpha_s\right\}, \quad \ell \in \mathbb{Z}_{\geqslant 0}$$

$$t_0^z = 0$$

The triggering parameter has no role in the estimation accuracy, the selection of this parameter does not depend on the observer dynamics, albeit it is an integral part of it.