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Event-triggered dynamic output-feedback control for a class of Lipschitz nonlinear systems

Key words: Lipschitz nonlinear system; Dynamic output-feedback control; Event-triggered control; Global asymptotic stability

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Motivation

1. Nonlinear systems with Lipschitz characteristics are in wide demand in the field of system modeling.
2. Output-feedback control is more general than state-feedback control, since full state measurements are often not possible in many scenarios.
3. Many researchers have devoted effort to the analysis of dynamic output-feedback control for nonlinear systems.
4. Event-triggered control allows considerable reduction of resource usage while guaranteeing the stability and maintaining a certain level of control performance.

Method

For a class of Lipschitz nonlinear systems, design a dynamic output-feedback controller.

Lipschitz nonlinear system:

$$\dot{\boldsymbol{x}} = \boldsymbol{A}\boldsymbol{x} + \boldsymbol{B}f(\boldsymbol{x}) + \boldsymbol{E}\boldsymbol{u}$$
$$\boldsymbol{y} = \boldsymbol{C}\boldsymbol{x}$$

Dynamic output-feedback control:

$$\dot{\boldsymbol{\xi}} = \boldsymbol{A}_{\mathrm{c}}\boldsymbol{\xi} + \boldsymbol{B}_{\mathrm{c}}\boldsymbol{y}$$
$$\boldsymbol{u} = \boldsymbol{C}_{\mathrm{c}}\boldsymbol{\xi} + \boldsymbol{D}_{\mathrm{c}}\boldsymbol{y}$$

Method (Cont'd)

Event-triggered control:

$$\bar{\boldsymbol{y}}(t) = \boldsymbol{y}(t_k),\ t_k \leq t < t_{k+1}.$$

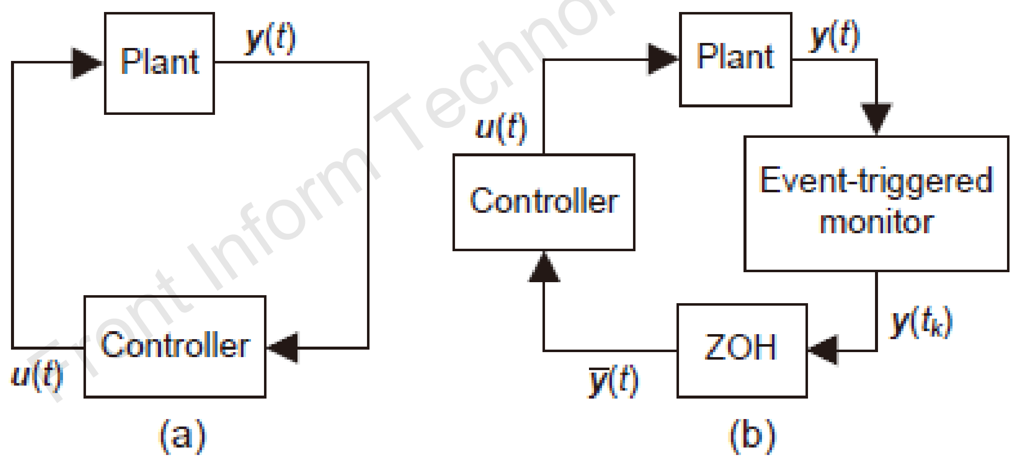

Fig. 1 Continuous-time (a) and event-triggered (b) dynamic output-feedback control schematics (ZOH: zero-order holder)

Method (Cont'd)

Formulate the event-triggered dynamic output-feedback control for the Lipschitz nonlinear system in the framework of hybrid system theory.

$$\mathcal{H}: \begin{cases} \begin{cases} \dot{\zeta} = f_a(\zeta, e) \\ \dot{e} = f_b(\zeta, e) \\ \dot{\tau} = 1 \end{cases} & (\zeta, e, \tau) \in \mathcal{F} \\ \begin{cases} \zeta^+ = \zeta \\ e^+ = \mathbf{0} \\ \tau^+ = 0 \end{cases} & (\zeta, e, \tau) \in \mathcal{J} \end{cases}$$

We need to design the following things:

1. Controller gains
2. Event-triggered conditions
3. Minimum inter-event interval

Simulation results

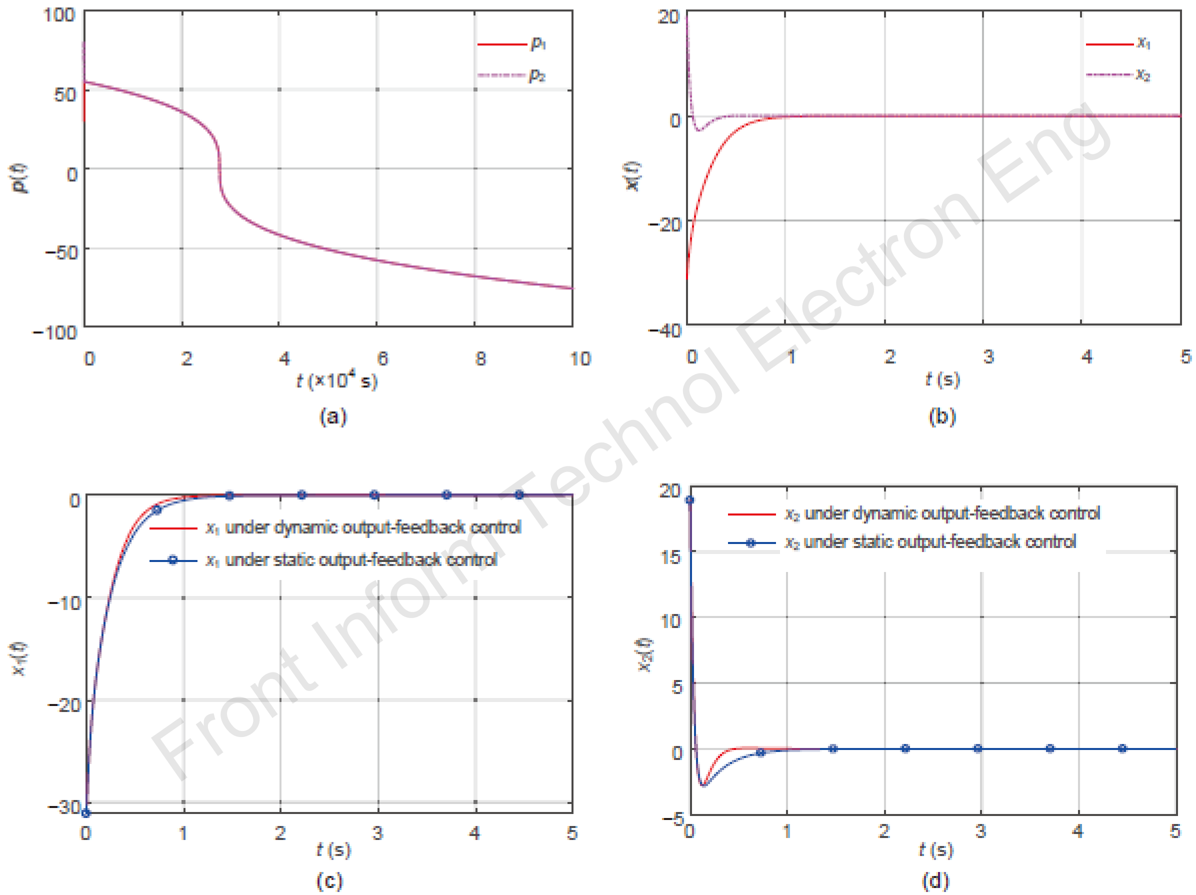

Fig. 3 Simulation results of Example 2: (a) evolutions of $p(t)$ of the genetic regulatory network system; (b) evolutions of $x(t)$ of the closed-loop error system under event-triggered dynamic output-feedback control; (c) evolutions of $x_1(t)$ under dynamic output-feedback (red line) and static output-feedback (blue-circle line) control; (d) evolutions of $x_2(t)$ under dynamic output-feedback (red line) and static output-feedback (blue-circle line) control. References to color refer to the online version of this figure

Conclusions

1. Continuous-time dynamic output-feedback control has been presented for a class of Lipschitz nonlinear systems.
2. Event-triggered dynamic output-feedback control has been proposed for a class of Lipschitz nonlinear systems.
3. The design of the dynamic output-feedback controller gains, the event-triggered conditions, and an upper bound of the minimum inter-event interval have been provided.

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