A NONLINEAR OBSERVER DESIGN FOR FERMENTATION SYSTEM FOR ETHANOL PRODUCTION BY SACCHAROMYCES CEREVISIAE

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Introduction. At present production of alcoholic beverages by Saccharomyces cerevisiae through a continuous fermentation process is gaining importance. However, it is not always possible to monitor process variables, either by lack of the sensor on the market or its high cost. An alternative is to design observers for unmeasured variables using information available measurable variables in the process. In this paper the design of a state observer for a biological process of alcohol production by S. cerevisiae is presented. The observer proposed contains a proportional type contribution and a sliding term for the measurement error, which provides robustness of the estimation against noisy model uncertainties.

Observer design methodology. The general structure of observer for ethanol system in Ec. (1) is:

$$\frac{d\hat{x}}{dt} = f(\hat{x}, u, y) + \Theta(\varepsilon)$$

Where $\varepsilon = x - \hat{x}$ is the error.

In Ec. (4) $\Theta(\varepsilon) = \pm K \varepsilon \pm \Phi(\text{sign}(\varepsilon))$

In this work $\Phi(\text{sign}(\varepsilon))$ has the following structure:

$$\Phi(\text{sign}(\varepsilon)) = G \text{sign}(\varepsilon) \exp(\varepsilon)$$

Here for the Ec. (5) note that term in Ec. (6) is bounded

$$||G\text{sign}(\varepsilon) \exp(\varepsilon)|| \leq 1$$

Considering Ecs. (3)-(4) and error dynamic

$$\frac{dx}{dt} = \frac{d\hat{x}}{dt} - \frac{dx}{dt}$$

is easy show that Ec. (7) can be expressed as:

$$||\varepsilon|| \leq \frac{g}{(L-k)}(1 - \exp(L-k) t) + \varepsilon_0 \exp(L-k) t$$

For $t \to \infty$

$$||\varepsilon|| \leq \frac{g}{(L-k)}$$

or $||\varepsilon|| \leq \frac{g}{L}$

Results. The proposed observer provides a good state estimation in Fig. 1, can be seen that the estimation error of the sliding mode observer is larger than that of the proposed observer.

Conclusions. Proposed observer presents acceptable performance compared to a sliding mode observer.

References.