ECE 680: Observers

Stan Żak

School of Electrical and Computer Engineering
Purdue University

zak@purdue.edu

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Today's Class

- Trivial observer

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- Trivial observer
- Closed-loop observer

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- Trivial observer
- Closed-loop observer
- Combined observer-controller compensator

Beginnings of the Observer

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- Observer—a dynamical system that estimates the system state based on the system inputs and outputs

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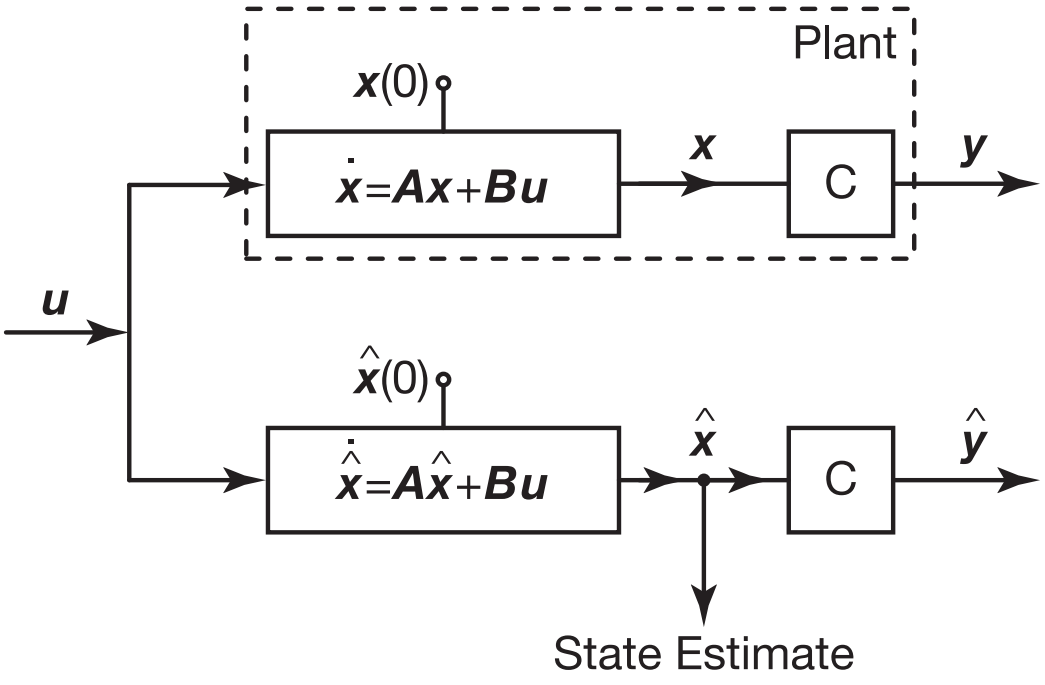
- Observer—a dynamical system that estimates the system state based on the system inputs and outputs
- D. G. Luenberger initiated the theory of observers in 1963 in his Ph.D. thesis at Stanford

Trivial Observer



Trivial Observer—Open-Loop Observer

- Trivial observer (open-loop observer)—a system copy as an observer

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- Trivial observer (open-loop observer)—a system copy as an observer
- Observation error,

$$e = x - \hat{x}$$

Problems With the Open-Loop Observer

- Observation error dynamics,

$$(\dot{x} - \dot{\hat{x}}) = \boldsymbol{A}(x - \hat{x})$$

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Problems With the Open-Loop Observer

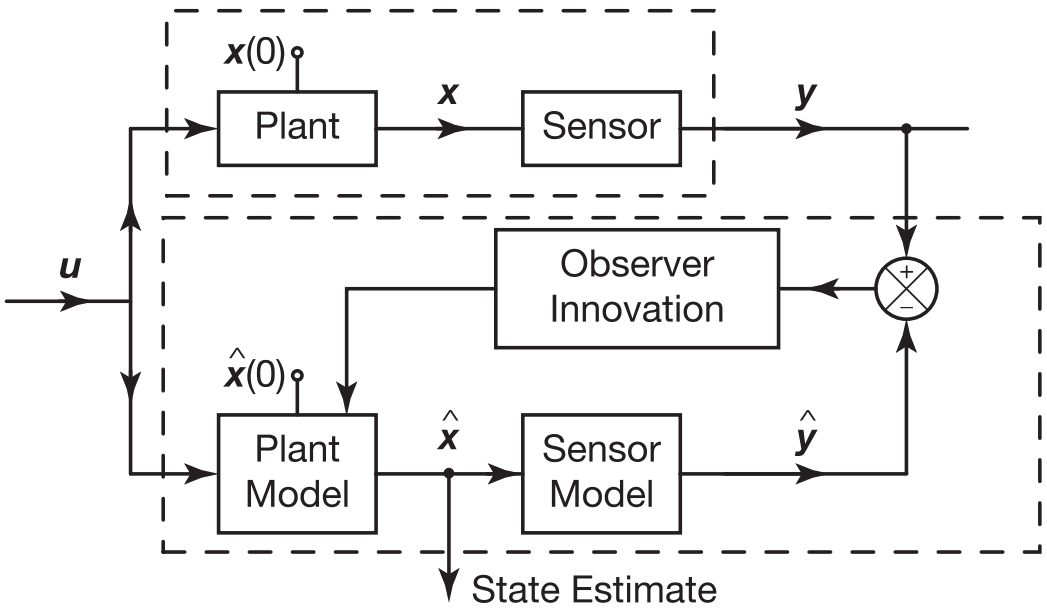
- Observation error dynamics,

$$(\dot{x} - \dot{\hat{x}}) = A(x - \hat{x})$$

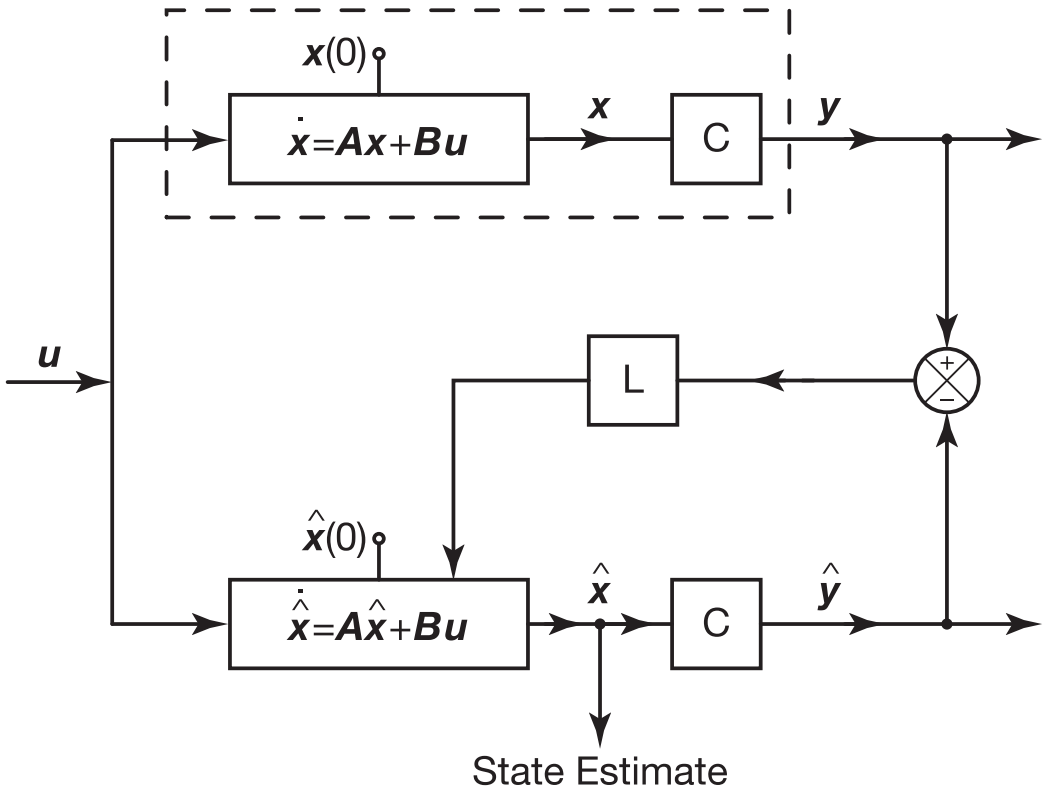
- The observation error tends to zero only if the observed system is stable
- There is no control over the observation error dynamics

Closed-Loop Observer

Fix the open-loop observer—add observer innovation to obtain the closed-loop observer



Luenberger's Closed-Loop Observer



$$\dot{\hat{x}} = A\hat{x} + Bu + L(y - \hat{y})$$

Estimation Error Dynamics

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- $$\dot{\hat{x}} = A\hat{x} + Bu + L(y - \hat{y})$$

- Observation error dynamics,

$$(\dot{x} - \dot{\hat{x}}) = (A - LC)(x - \hat{x})$$

Combined Observer-Controller Compensator