

# ELE 457 Feedback Control System

Dr. Richard Vaccaro

Dr. Helen Huang

Department of Electrical, Computer &  
Biomedical Engineering

University of Rhode Island

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# About This Class

- Syllabus
- Class policy
  - Late homework will NOT be accepted.
  - Quiz: No text book & note is allowed.
  - Exam: no text book & note is allowed
  - All students in this class are expected to adhere to university standards of academic integrity.  
[\(http://www.cba.uri.edu/home/current/AcademicHonestyandIntegrity/\)](http://www.cba.uri.edu/home/current/AcademicHonestyandIntegrity/)  
Cheating, plagiarism, and other forms of academic dishonesty will not be tolerated. This includes, but is not limited to, consulting with another person during an exam, turning in written work that was prepared by someone other than you, and making minor modifications to the work of someone else and turning it in as your own. Any cheating, plagiarism, or other form of academic dishonesty will result in a grade of “F” for this course, as well as the notification of the appropriate College of Engineering authority.

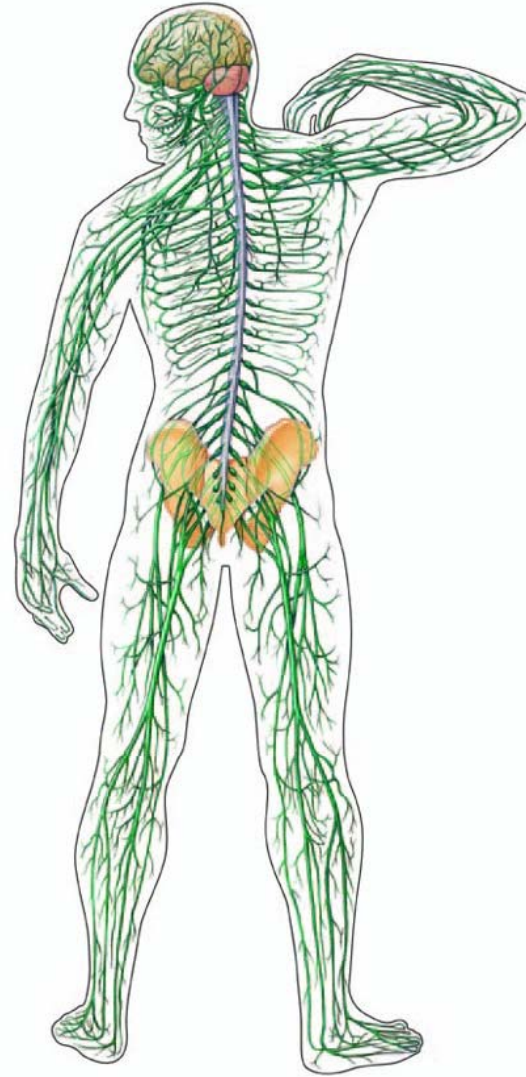
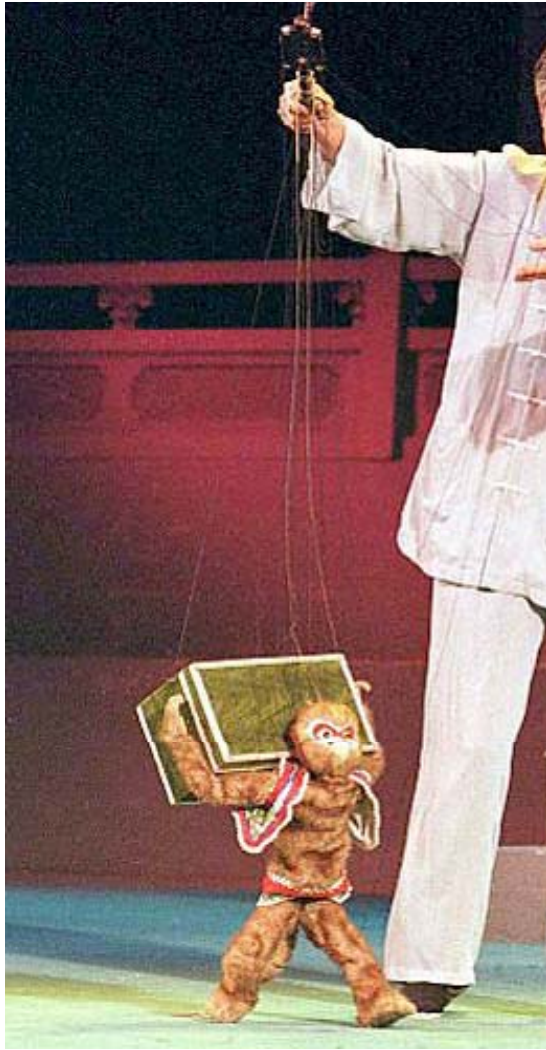
# Flu Policy

- The H1N1 Flu Pandemic may impact classes this semester. If any of us develop flu-like symptoms, we are being advised to stay home until the fever has subsided for 24 hours. So, if you exhibit such symptoms, please do not come to class. Notify me at 874-5816 or [vaccaro@ele.uri.edu](mailto:vaccaro@ele.uri.edu) of your status, and we will communicate through the medium we have established for the class. We will work together to ensure that course instruction and work is completed for the semester.
- The Centers for Disease Control and Prevention have posted simple methods to avoid transmission of illness. These include: covering your mouth and nose with a tissue when coughing or sneezing; frequently washing your hands to protect from germs; avoiding touching your eyes, nose and mouth; and staying home when you are sick. For more information, please view [www.cdc.gov/flu/protect/habits.htm](http://www.cdc.gov/flu/protect/habits.htm) [<http://www.cdc.gov/flu/protect/habits.htm>](http://www.cdc.gov/flu/protect/habits.htm) . URI information on the H1N1 will be posted on the URI website at [www.uri.edu/news/h1n1.html](http://www.uri.edu/news/h1n1.html) and <http://www.uri.edu/news/h1n1> , with links to the [www.cdc.gov](http://www.cdc.gov) [<http://www.cdc.gov>](http://www.cdc.gov) site.

# Some tips for success

- Allow plenty of time for study
- Ask for help early if needed
- Don't procrastinate on studies and assignments

# What is control system?



# What is control system?



# Control System is...

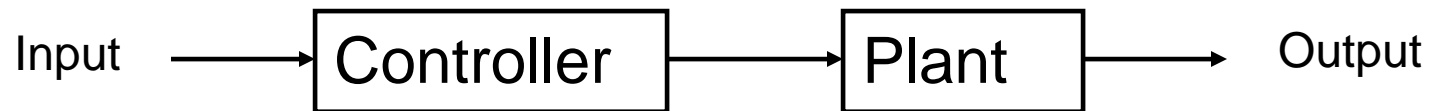
a system to manage, command, direct, or regulate the behavior of other devices or systems.

- Open loop
- Close loop



Asimo, Honda

# Open-Loop Control



Plant: the system to be controlled

Controller: used to obtain satisfactory characteristics for the total system

Example: Steering wheel → direction

# Is an open-loop system robust?

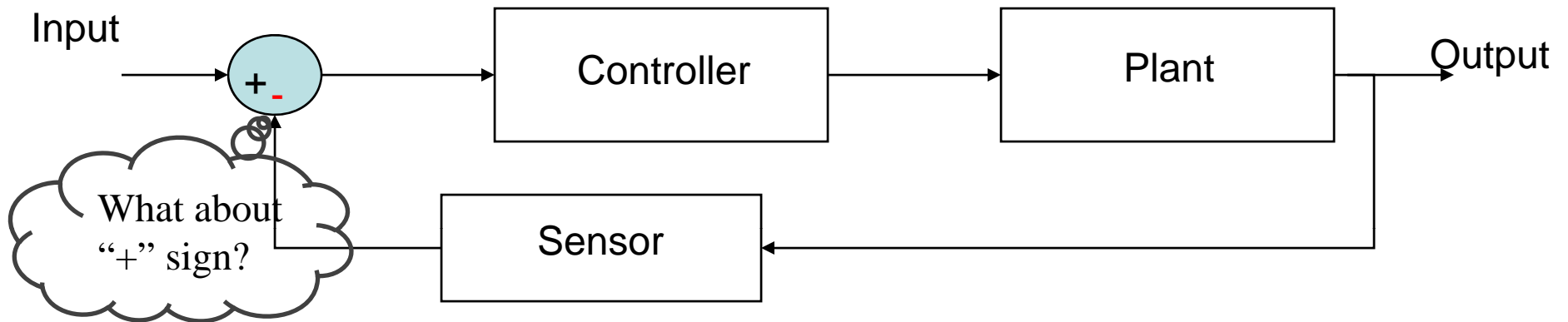
The open-loop system cannot compensate for disturbances

Useful for well-defined systems where the relationship between input and the resultant state can be modeled by a mathematical formula.

Example: Steering wheel → direction

- What about driving on an icy road?

# Feedback Control System



Plant: the system to be controlled

Sensor: a device which converts a physical variable to a measurable variable

Controller: used to obtain satisfactory characteristics for the total system

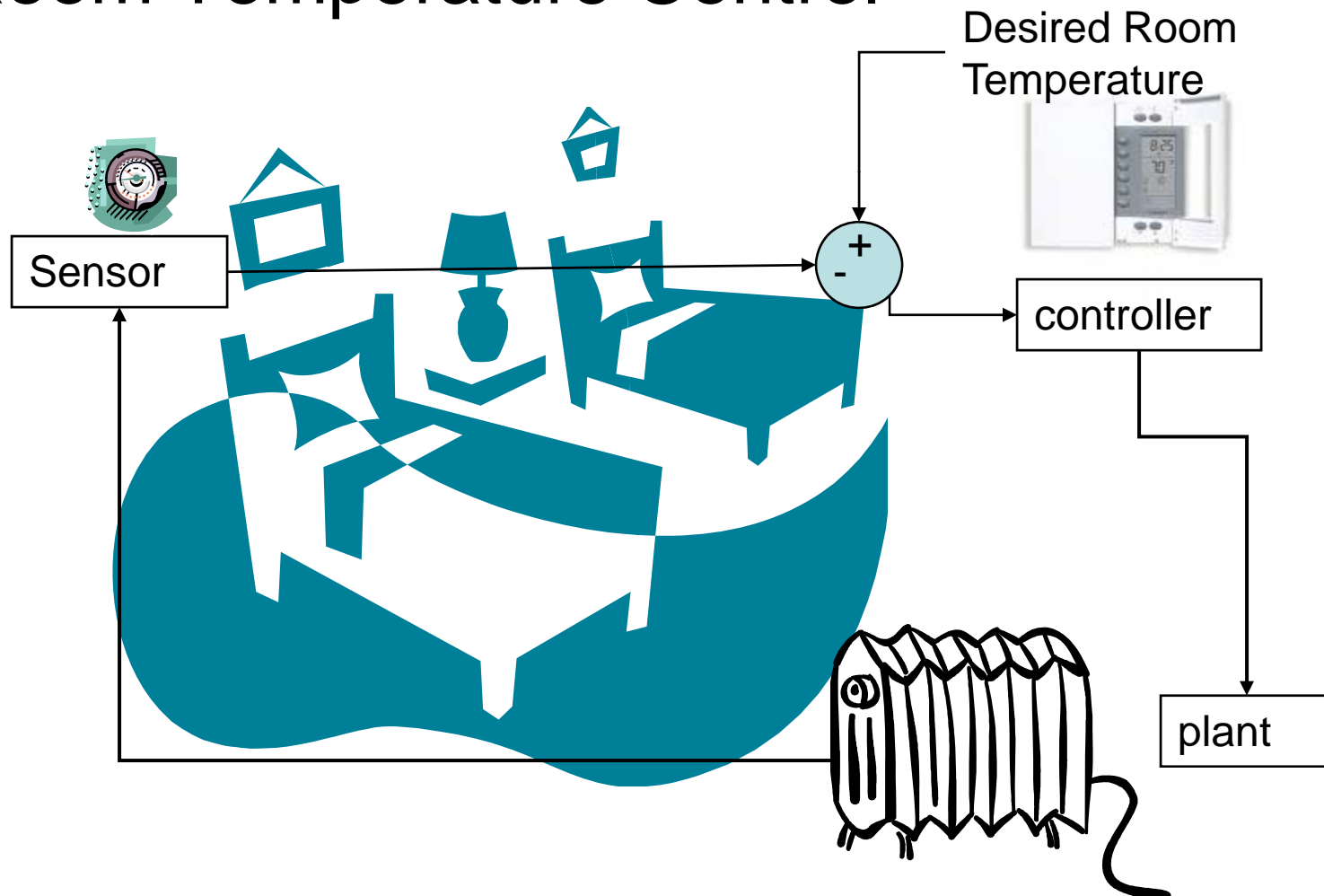
Control system: Regulator

Servomechanism

- Regulator: If the object of the control system is to maintain a physical variable at some constant value in the presence of disturbances, we call this system a regulator.
- Servomechanism: A control system in which a physical variable is required to follow, or track, some desired time function.

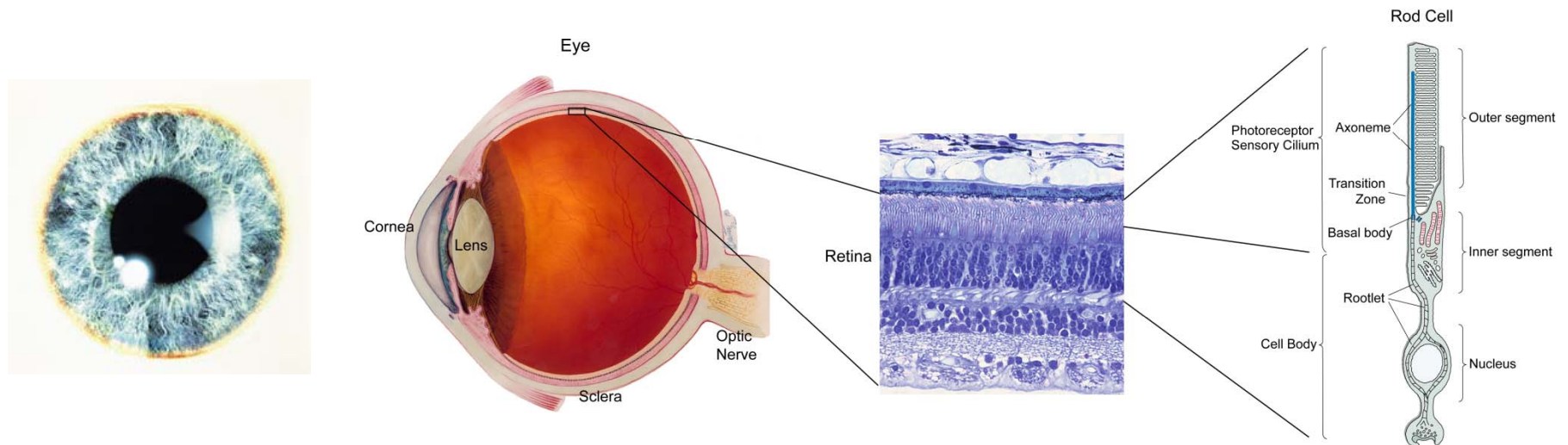
# A Simple Example

- Room Temperature Control



# Another Example

- Human Pupil Control (pupillary light reflex): control an amount of light shone into the eye



# Why feedback control

- Advantage
  - Feedback allows high performance in the presence of uncertainty
  - Feedback allows the dynamic of a system to be modified
- Disadvantage
  - Introducing instability

# Desired Characteristics of Control system

- Stability
- Disturbance rejection
- Static state accuracy
- Transient response
- Sensitivity

# Control Theory is...

an interdisciplinary branch of engineering and mathematics, that deals with the behavior of dynamical systems.

- Classical
- Modern

# What is control engineering?

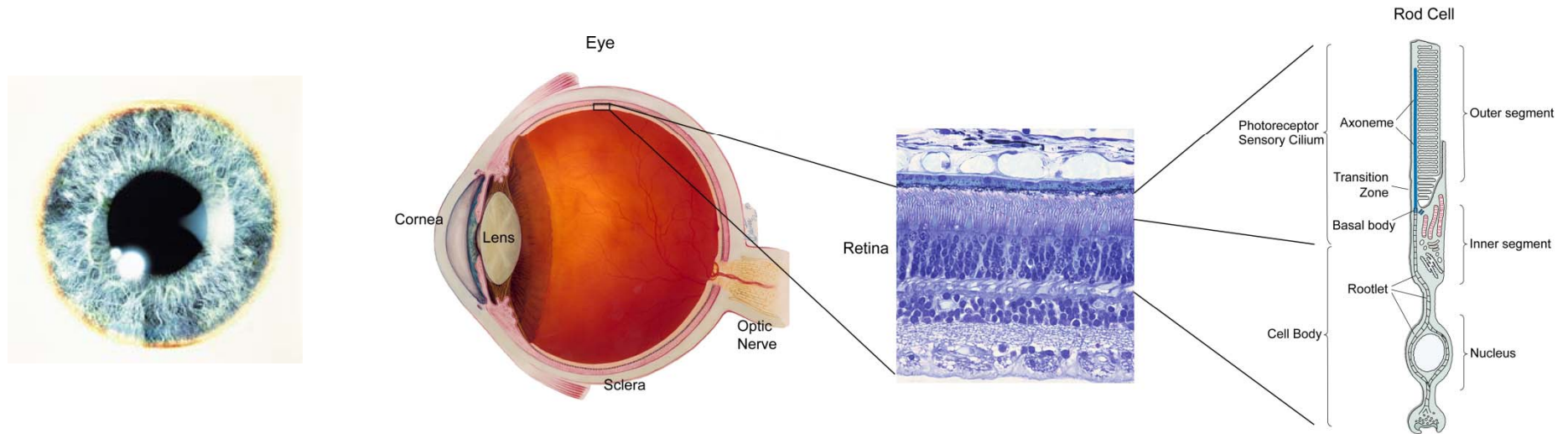
- Control Engineering is the engineering discipline that applies control theory to design systems with predictable behaviors.

# What do we need to learn?

- System modeling
- Control theory
- Modeling and Simulation
- Hardware and software

# For Example

- Design an artificial iris that can control an amount of light shone into the eye



# Design Procedure

- Modeling a pupil reflex system based on physiological experiments
- Modeling mechanical property of artificial iris (plant), implantable sensor (sensor)
- Design the controller
- Simulation
- Hardware design and medical application

# Control Theory

- Classical Control Theory is based on a transfer function description.
  - Transfer function is presented in the complex-S domain
  - Used in single input single output system
  - Usually is limited to linear systems and zero initial conditions
- Modern Control Theory uses “time-domain” state space approach
  - Used in multiple inputs multiple outputs system
  - Usually is not limited to systems with linear components and zero initial conditions
- In this course, we only deal with classical control theory.

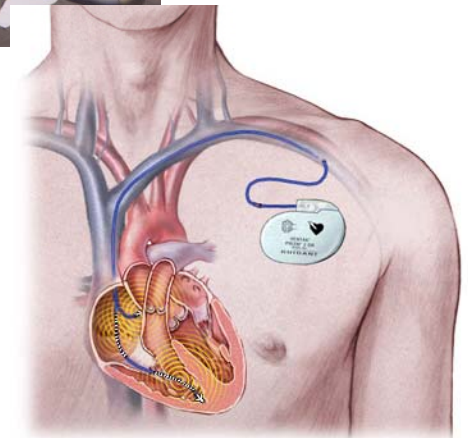
# Why we need to know control

Control is an essential element of almost all engineering systems.

- Electrical
- Computer
- Biomedical
- Mechanical

**Give me an example in your field!**

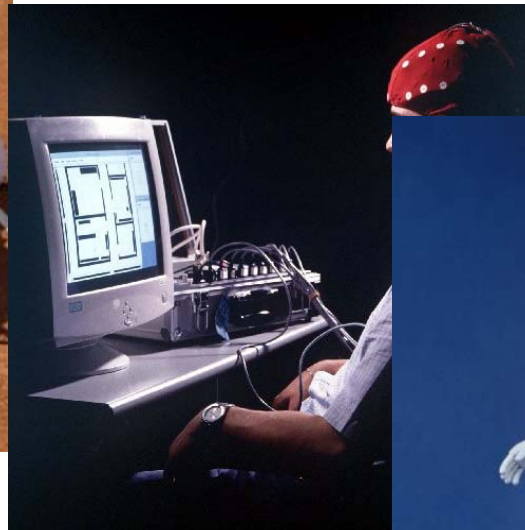
# Examples



# Other Examples



Serena Williams



Asimo, Honda

# References

- [http://en.wikipedia.org/wiki/Control\\_system](http://en.wikipedia.org/wiki/Control_system)
- CL Phillips, RD Harbor. Feedback Control Systems. 4<sup>th</sup> edition. 2000
- [http://en.wikipedia.org/wiki/Pupillary\\_light\\_reflex](http://en.wikipedia.org/wiki/Pupillary_light_reflex)

Home work: read chapter 1