CDS 110: Lecture 1.2
Applications of Control

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Goals:

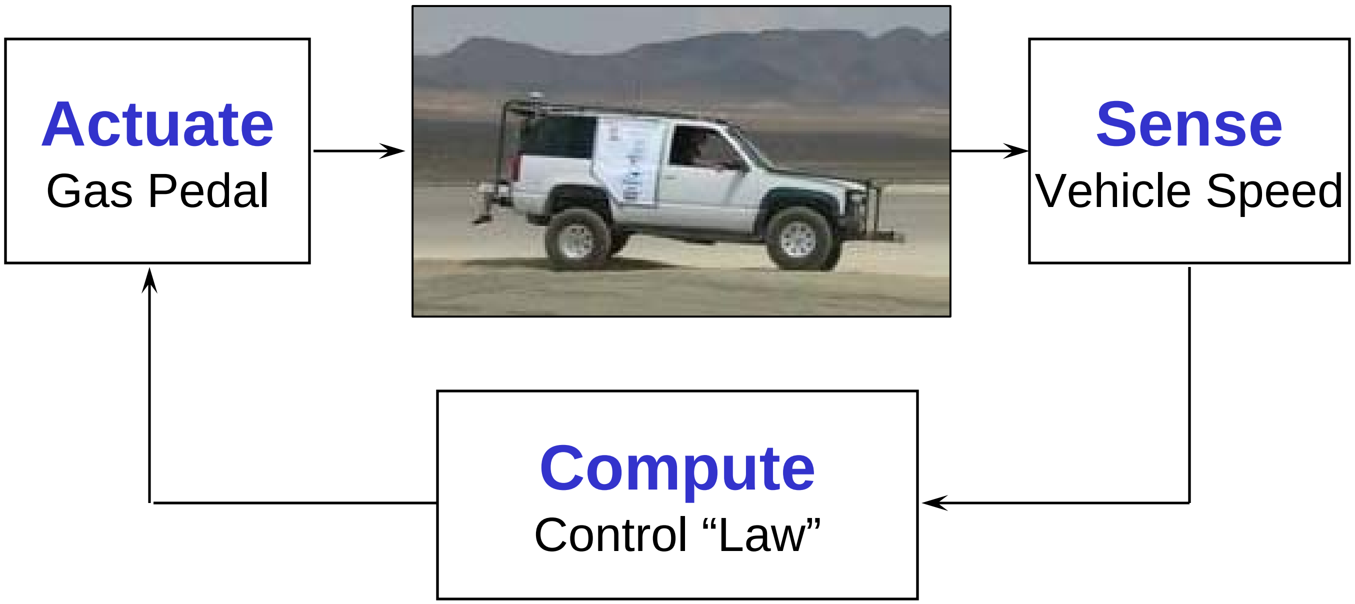
- Describe modern engineering environment for control
- Survey engineering applications of control and key features
- Provide information on CDS 110 sections; explain schedule process
- Honor System discussion

Reading (available on course web page):

- Optional: R. Murray (ed), *Control in an Information Rich World,* 2003.

Control = Sensing + Computation + Actuation

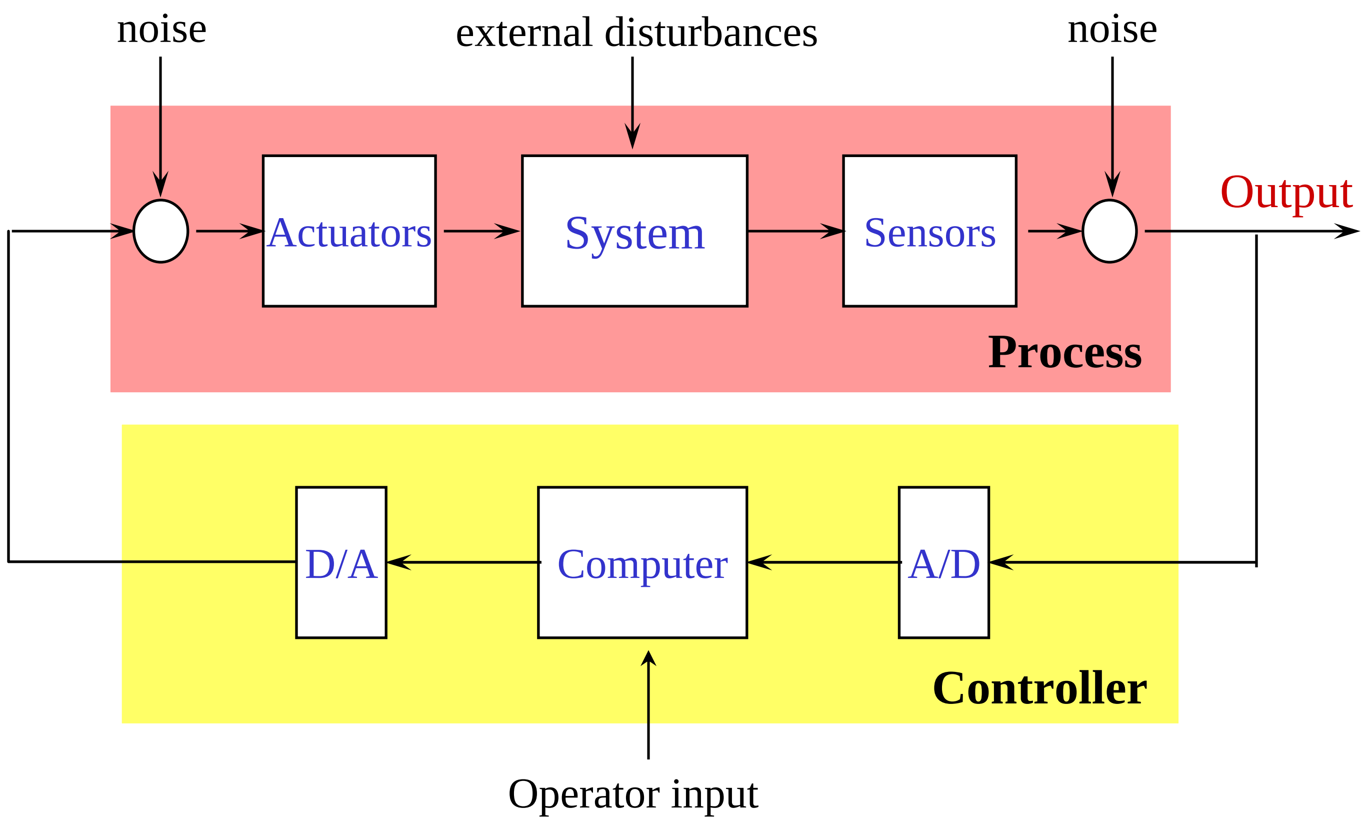
In Feedback "Loop"



Goals

- Stability: system maintains desired operating point (hold steady speed)
- Performance: system responds rapidly to changes (accelerate to 6 m/sec)
- Robustness: system tolerates perturbations in dynamics (mass, drag, etc)

Modern Control System Components



Process	Physical system, actuation, sensing
Controller	Microprocessor plus conversion hardware (single chip)
Feedback	Interconnection between plant output, controller input

Active Control Methodologies

Black box methods

- Basic idea: learn by observation or training
- Examples: auto-tuning regulators, adaptive neural nets, fuzzy logic

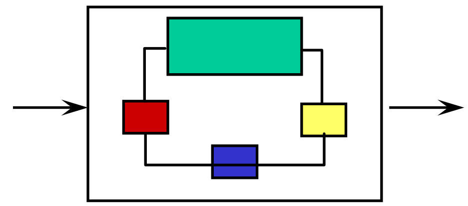
Advantages:

- No need for complex modeling or detailed understanding of physics
- Works well for controllers replacing human experts

Disadvantages:

- No formal tools for investigating robustness and performance
- Don't work well for high performance systems with complicated dynamics

Model-based methods



- Use a detailed model (PDEs, ODEs) for analysis/design
- Examples: optimal regulators, $H_{\mathcal{I}}$ control, feedback linearization

Advantages:

- Works well for highly coupled, multivariable systems
- Rigorous tools for investigating robust-ness and performance (using models)

Disadvantages:

- Tools available only for restricted class of systems (e.g., linear, time-invariant)
- Requires control-oriented physical models; not always easy to obtain

Biomolecular and Chemical Processes

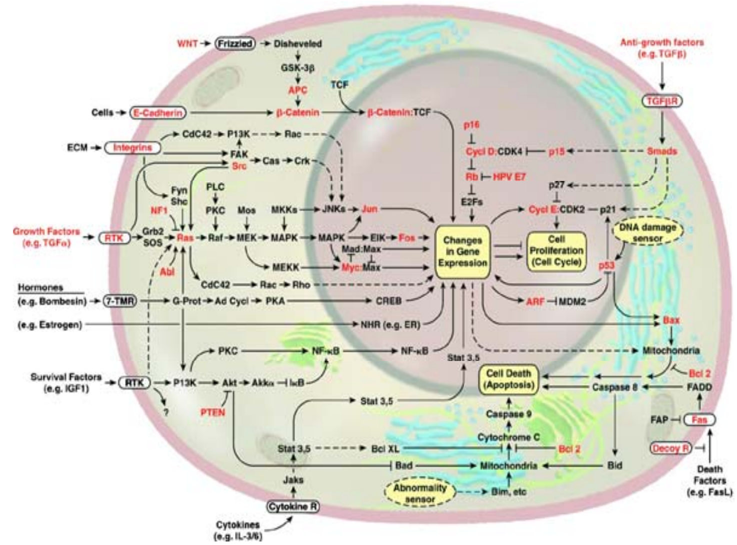
TAs: Domitilla Del Vecchio, Steve Chapman

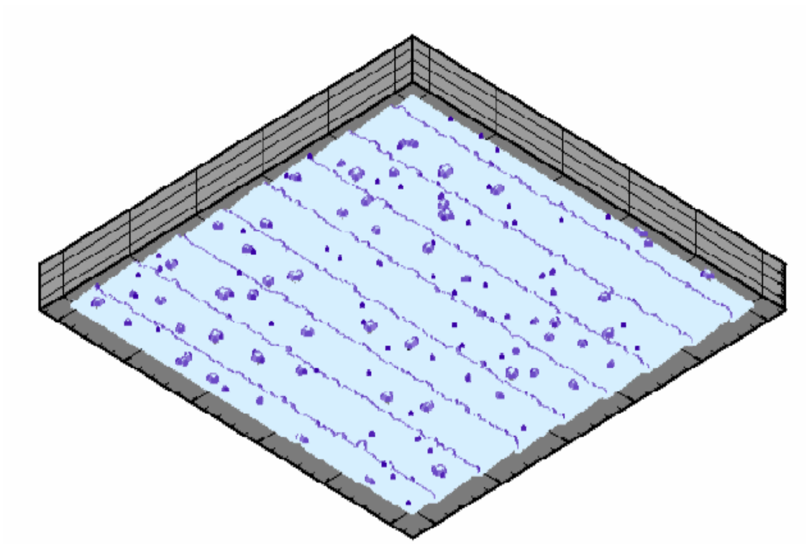
Instructor: Anand Asthagiri

Application areas

- Chemical process control
- Biological feedback systems

Primary options: BE, Bio, ChE, MS





Information Systems

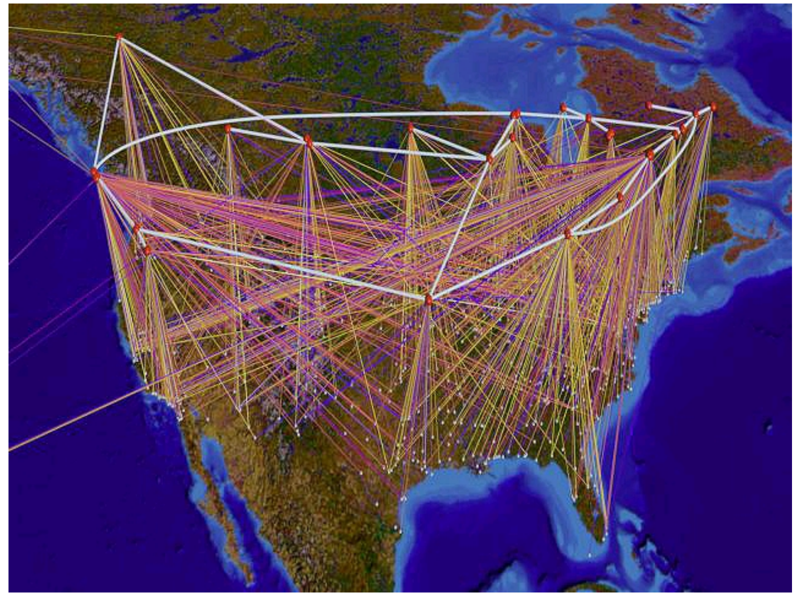
TAs: Morr Mehyar, Kevin Tang

Instructor: Steven Low

Application areas

- Communications networks
- Software systems
- Economic systems

Primary options: CS, Ec, EE, SS



Mechanical and Aerospace Systems

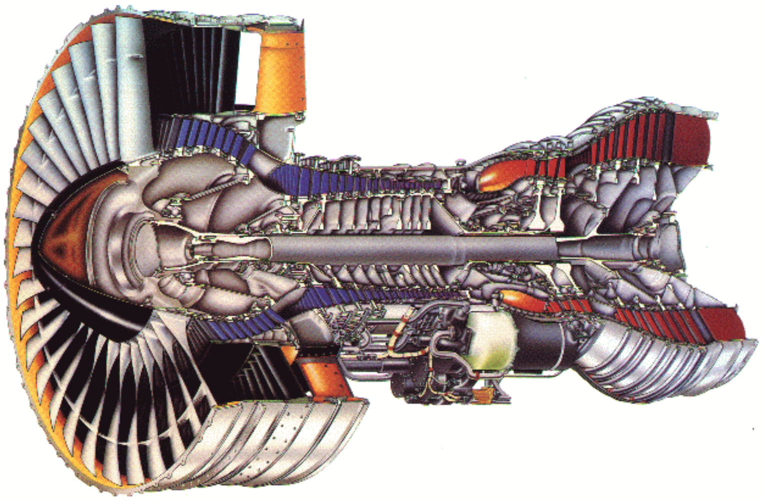
TAs: Hao Jiang

Instructor: Tim Colonius

Application areas

- Servo systems
- Fluid systems
- Flight control

Primary options: Ae, ME



Electrical and Electronic Systems

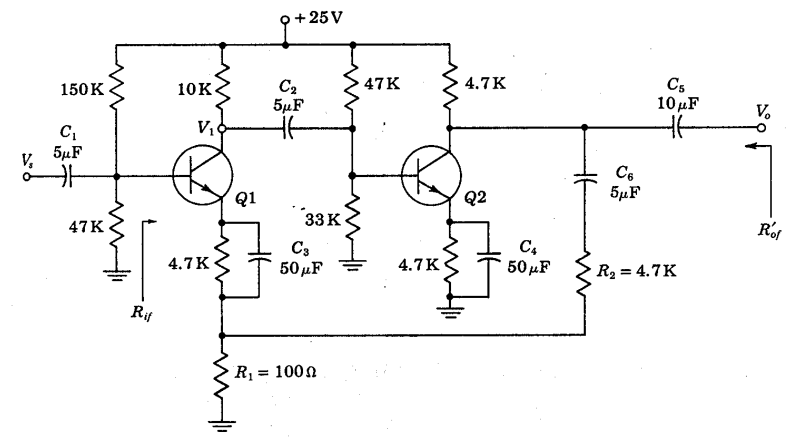
TAs: Asa Hopkins

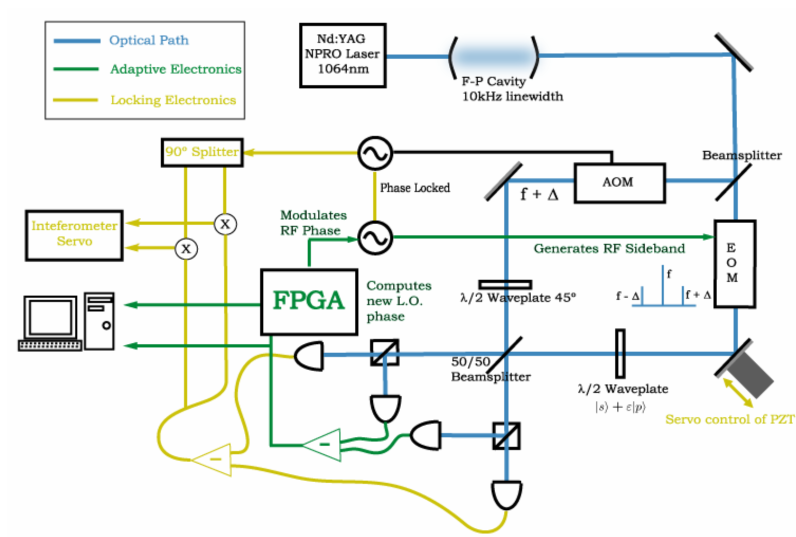
Instructor: Ali Hajimiri, Hideo Mabuchi

Application areas

- Electronic systems
- Optical systems
- Photonics/quantum systems

Primary options: APh, EE, Ph





Robotics and Autonomy

TAs: Haomiao Huang, Demetri Spanos

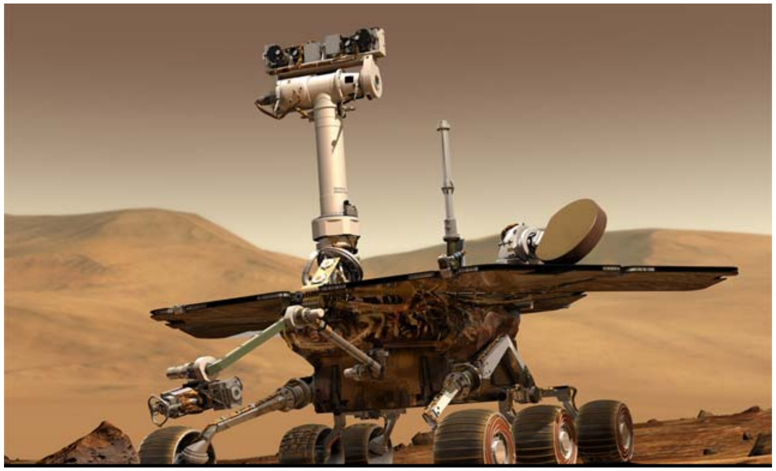
Instructor: Richard Murray

Application areas

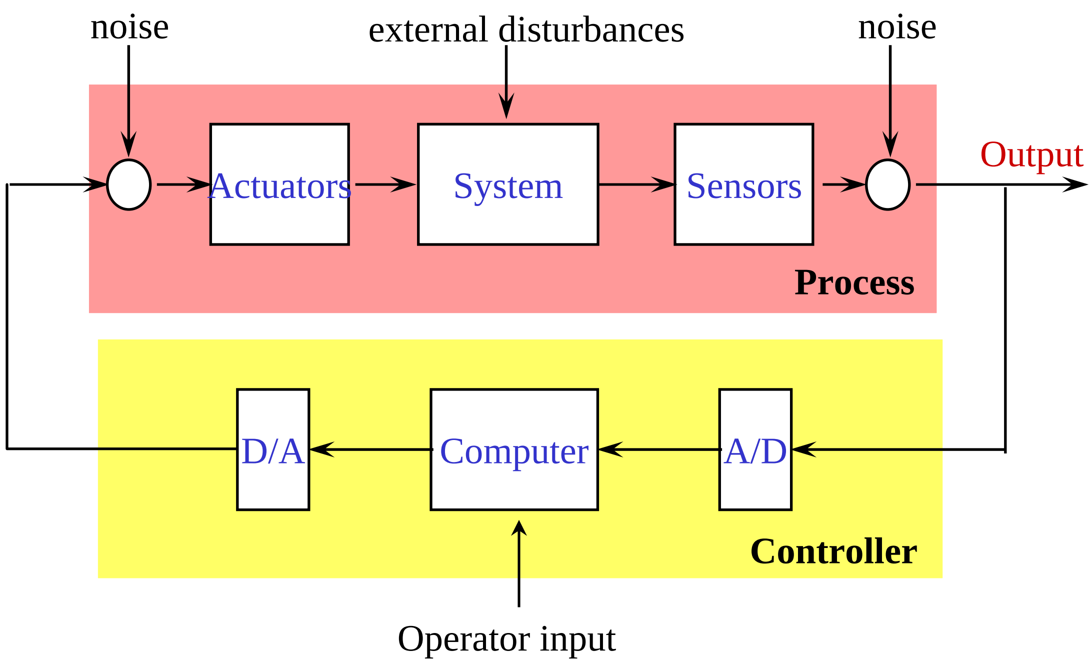
- Autonomous robot systems
- Sensor-based navigation
- DARPA grand challenge

Primary options: CS, EE, ME

- Opportunities for hardware implementation on “Bob” or “Homer”

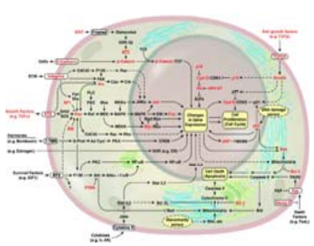


Summary: Applications of Control



Modern applications of control

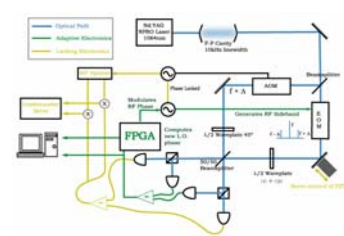
- Control = sensing, actuation and computation
- Digital control systems are increasingly common
- Applications across engineering and science



Molecular and chemical processes

Information Systems

Mechanical and Aero Systems



Electrical and Electronic Systems

Robotics and Autonomy