How to make something that makes almost anything: Controls

Nadya Peek

March 2015

A control system: dynamically regulate

Input (setpoint, reference)

Output (the thing you want to regulate)

Open loop: input independent from output

Closed loop: input depends on output

Block diagrams vs. mathematical models:

"Dont apply any model until you understand the simplifying assumptions on which it is based, and you can test their validity. Catch phrase: use only as directed.

Don't limit yourself to a single model: More than one model may be useful for understanding different aspects of the same phenomenon. Catch phrase: legalize polygamy."

Saul Golomb, *Mathematical Models- Uses and Limitations*, 1970

For our purposes: Position control

Stepper motors

DC motors + encoders

Servos

(next week: force control)

Feedback:

Accuracy (esp when dealing with noise and nonlinearities)

Bandwidth (frequency response measure)

but also... Oscillation and instability!

Analog vs. digital:

Depends on what the method of control is

When your feedforward element includes a microcontroller...

In a discrete-time signal, the sampling rate may become a problem

Transducers!

The black art of tuning:

autotune

search

Ziegler-Nichols

... adaptive tuning

all also will have to do with your sample and update rate!

Stability

(observability)

Bandwidth

Interfering feedback loops:

independent systems

interrupts

Pesky physics: Inertia

In moving mass– both motors and machine parts

speed, acceleration, energy

jerk

look ahead

smoothing

Pesky physics: Nonlinearity

backlash

wear

Object oriented hardware and levels of control