ICT 41205 Digital Control Systems

Introduction to Digital Control Systems

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Digital Control Systems

Controlling systems using digital signals

What are Systems?

Systems

A set of things working together as parts of a mechanism

- Natural Systems
  - Human body
- Artificial Systems
  - Automotive vehicle

Dynamic Systems

Example

Fan vs. Air Conditioner

Systems with inputs and outputs: how the input affects the output or what input should be given to generate a desired output.

Dynamic Systems

Systems that evolve with time

What is Control?

Control

Change the behaviour of a system

Digital Control

The control laws are implemented in a digital device

Examples of Digitally Controlled Systems

- housing
  - in-house temperature regulation
- automotive industry
  - speed regulators in cars
- aeronautic/space industry
  - autopilots, automatic take off/landing
- robotics
  - robot-arm trajectory control

Advantages of Digital over Analogue

- Speed
  - Superior performance at very fast speeds with digital computers
- Accuracy
  - Digital signals are more accurate
- Flexibility
  - Controller can be modified without complete replacement
- Cost
  - Digital controllers are more economical to build
- Implementation Errors
  - Implementation errors are negligible

Signals

- A magnitude which varies with time
- Variable, not constant
- Simple or complex
- Sound, thermal, etc.

Type of signals

- Binary
- Digital
- Continuous
- Fuzzy - not well defined
- Stochastic - unpredictable

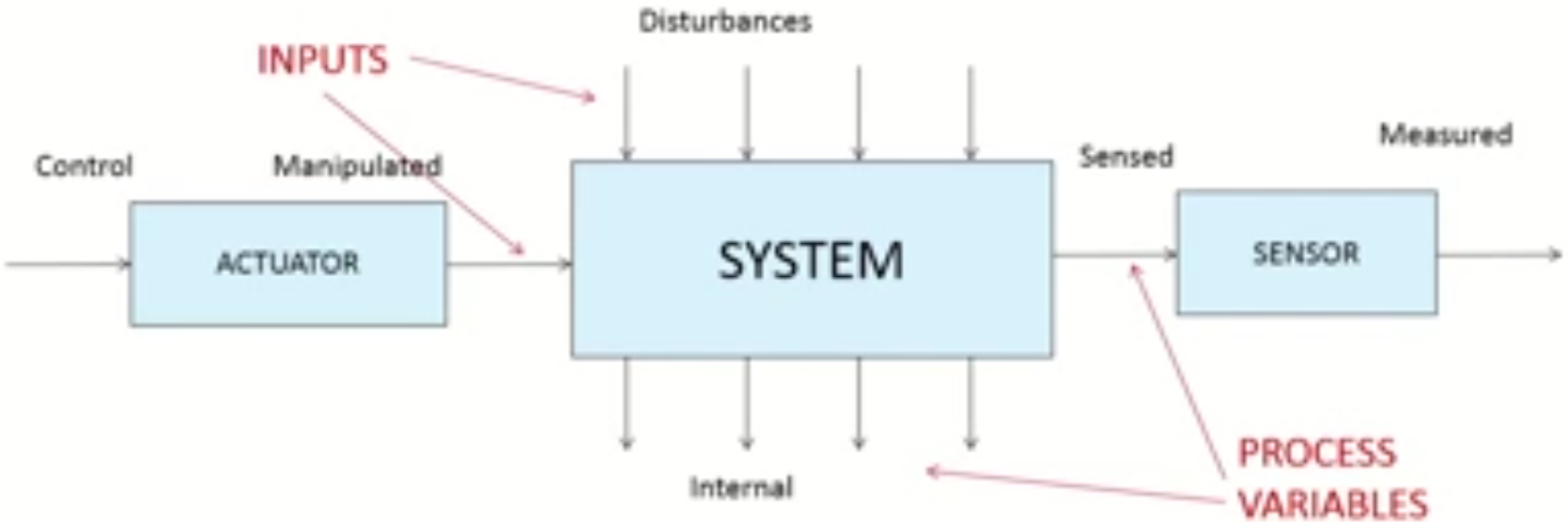
System variables

Input Signals:

- Manipulated
  - can be controlled
- Disturbances
  - cannot be controlled

Process Variables:

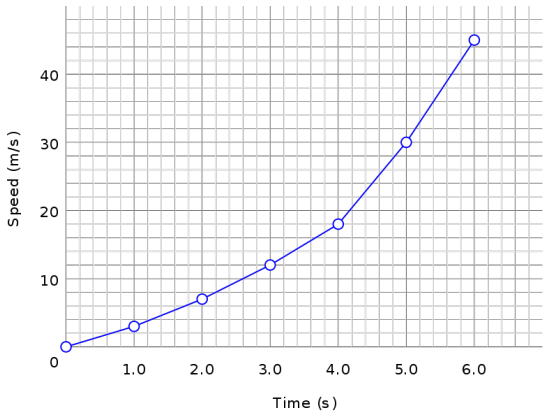
- External
  - can be sensed
- Internal
  - within the system



Systems related to signals

- Signal generators (sine wave)
- Signal processes (filer, sampler)
- Sensors or transducers (microphone)
- Receivers and transmitters

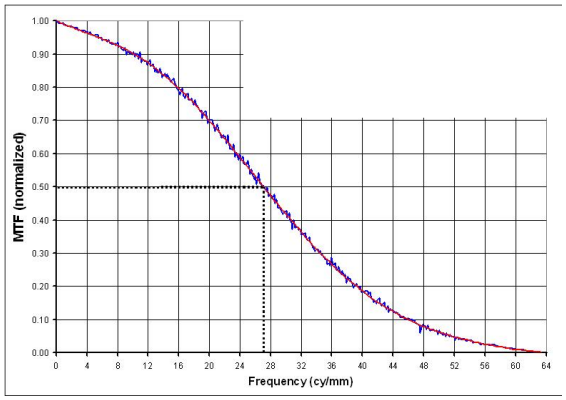
Representation of Signals



graph or table

$$v(t)$$

function of time

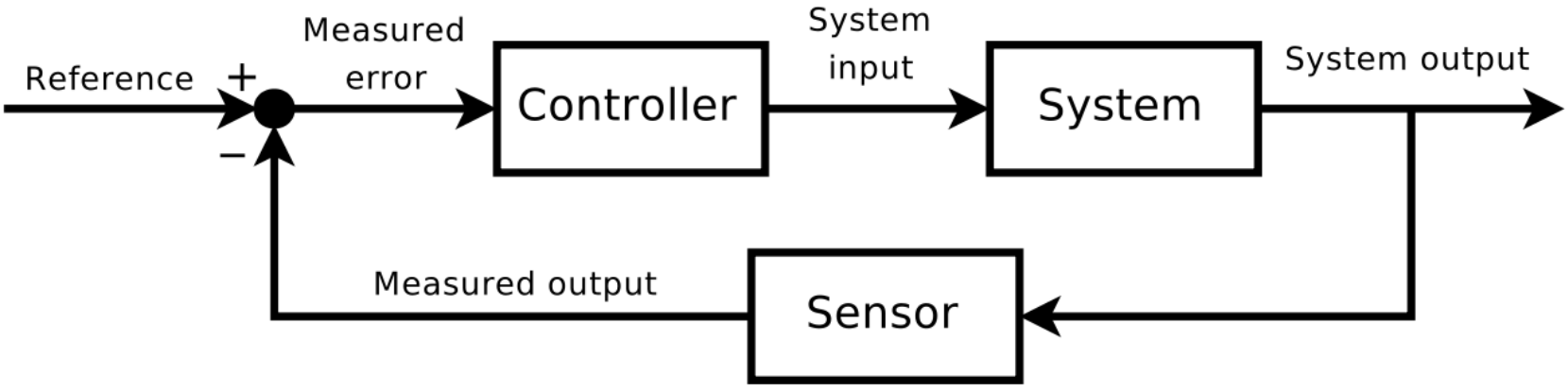


information + noise

Control System Structure

- Open-loop
  - set goals, no disturbances, no measurements
- Closed-loop
  - operator sets goals, controller sets variables with measurements
- Supervisory
  - operator supervise closed-loop references
- Cascade
  - sub-processes
- Feed-forward
  - sense disturbance and control input generated
- Two degrees of freedom
  - two controllers to adjust different aspects of process
- Hierarchical
  - hierarchical sub-processes, with central coordinating

Closed-loop Digital Control Systems



In a closed loop control system, the variable to be controlled (controlled variable / system output) is continuously measured and then compared with a predetermined value (reference variable).

What do you want to learn?