Digital Control Systems Technology

...

(formally Digital Control Systems)

Nimal Skandhakumar

Faculty of Technology
University of Sri Jayewardenepura

2019

Introduction to Class

Staff

- Lecturer
  - Dr. Nimal Skandhakumar
- Instructors
  - TBC

Course Contents

- Introduction
- Interfacing Analogue and Digital Worlds
- Hardware/Software Co-design
- Control System Components
- Control System Design
- Project

Grading

Activities	Percentages
Continuous Assessment, Quiz, Practicals	10
Group Project	30
Final Exam	60

Resources

- Office Hours
  - Monday 1:00 PM - 2:00 PM
    - If alternative times are preferred, let me know.
- Lecture slides, etc.:
  - http://lms.tech.sjp.ac.lk/course/view.php?id=9
  - https://academic.nimal.info/

Introduction to Digital Control Systems

Controlling systems using digital signals

What are Systems?

A set of things working together as parts of a mechanism

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

Dynamic Systems

Systems that evolve with time

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

- Example
  - Fan vs. Air Conditioner

What is 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

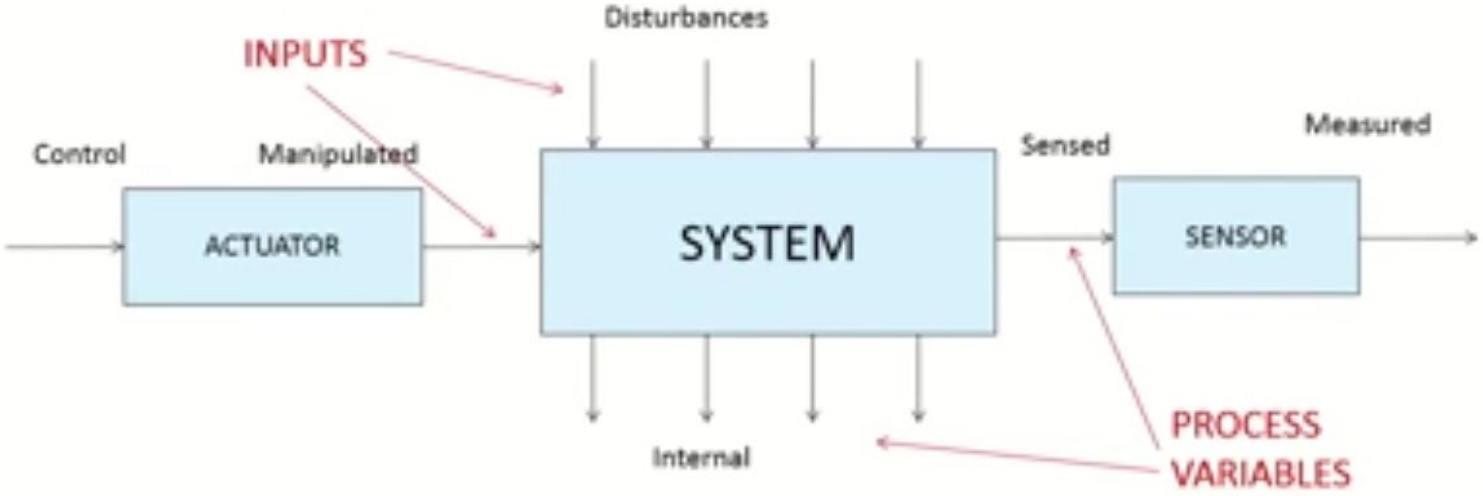
System variables

Input Signals:

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

Process Variables:

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

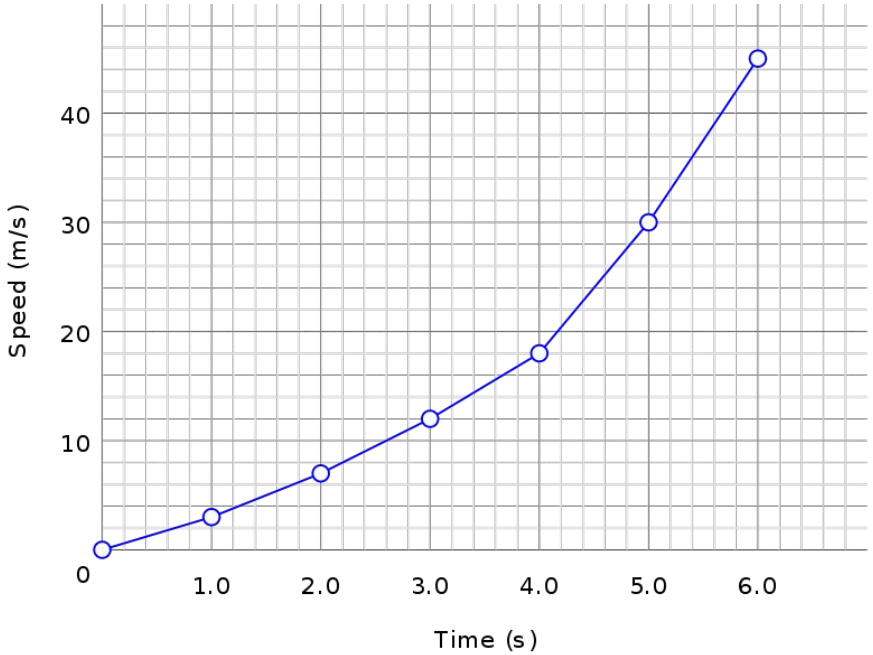


Systems related to signals

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

Representation of Signals

- graph or table

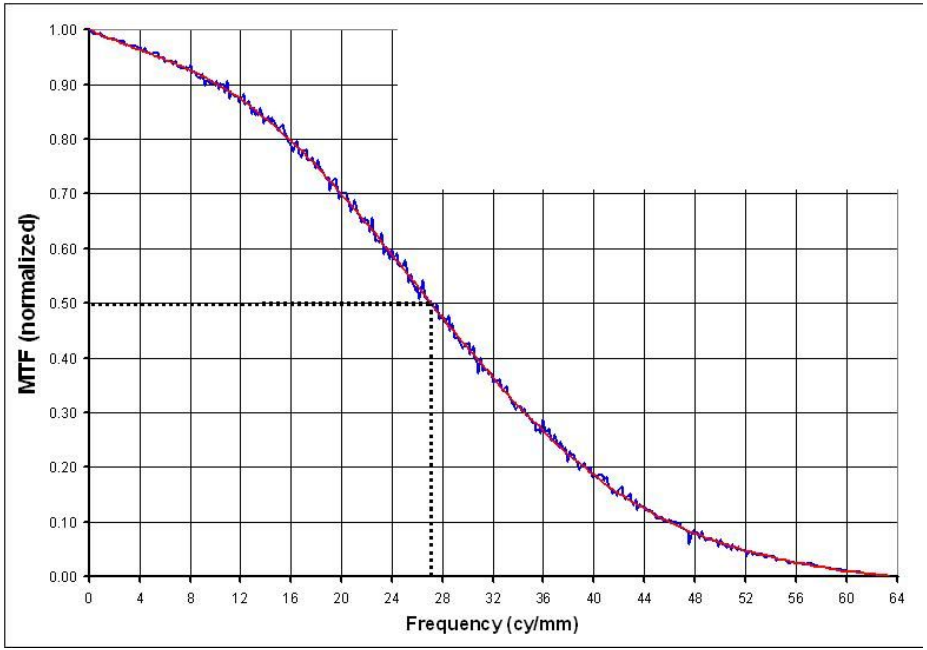


- function of time

$$v(t)$$

Representation of Signals

- information + noise



Control System Structures

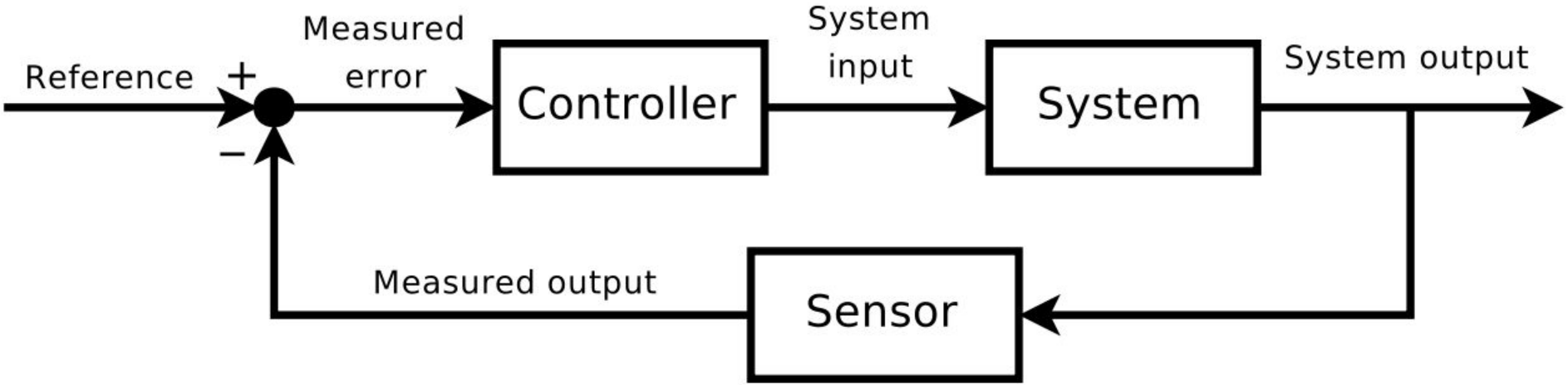
- Open-loop
  - set goals, no disturbances, no measurements
- Closed-loop
  - operator sets goals, controller sets variables with measurements

Control System Structures

- 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?

Group Project

Build a closed-loop control system

- Group size:
  - 4-6
- Skills:
  - Electronics, Programming, Research, Project Management

Ask Early, Ask Often.