ECED4601: Digital Control Systems

Part I--Introduction

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Outline

i. Introduction
ii. Digital control history
iii. Digital control systems
iv. Quantizing and quantization error
v. Data acquisition and distribution

I. Introduction

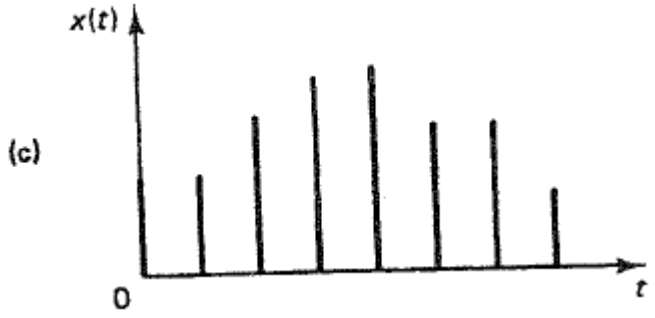
i. Digital control advantages:
   i. Maximum productivity, profit, minimum cost, energy.
   ii. Optimization in fuel economy
   iii. Decision making capability
   iv. Flexibility

I. Introduction

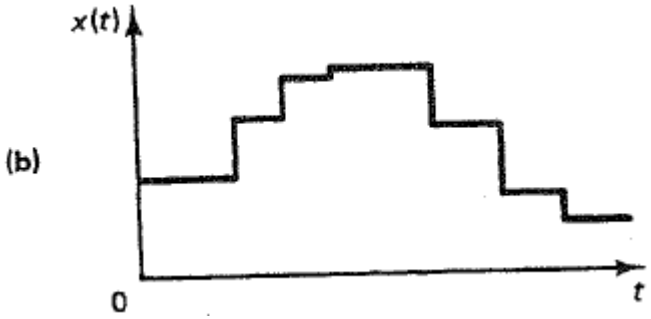
i. Type of signals
   i. Continuous vs discrete time
   ii. Analog vs digital
i. Type of system
   i. Continuous time control system vs discrete time control system
   ii. LTI vs non linear system
i. Type of representation
   i. Differential equation vs difference equation

I. Introduction

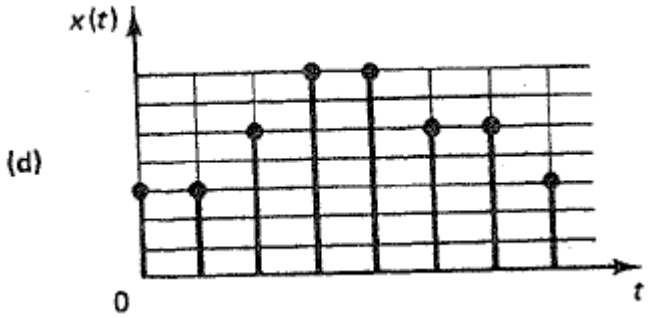
a) Continue time analog signal



c) Sample-data signal



b) Continues time quantized signal



d) Digital signal

II. Digital control history

i. Computer started 1940s and early 1950s (the Colossus computer, made by Alan Turing). 5000 and 58,000 vacuum tubes per computer.

ii. The first example of an electronic supervisory control system was made by the Hughes Aircraft Company called the Digitrack in 1954.

iii. In 1959, the Texaco Company used the first digital computer based control

iv. RW-300, from 1962

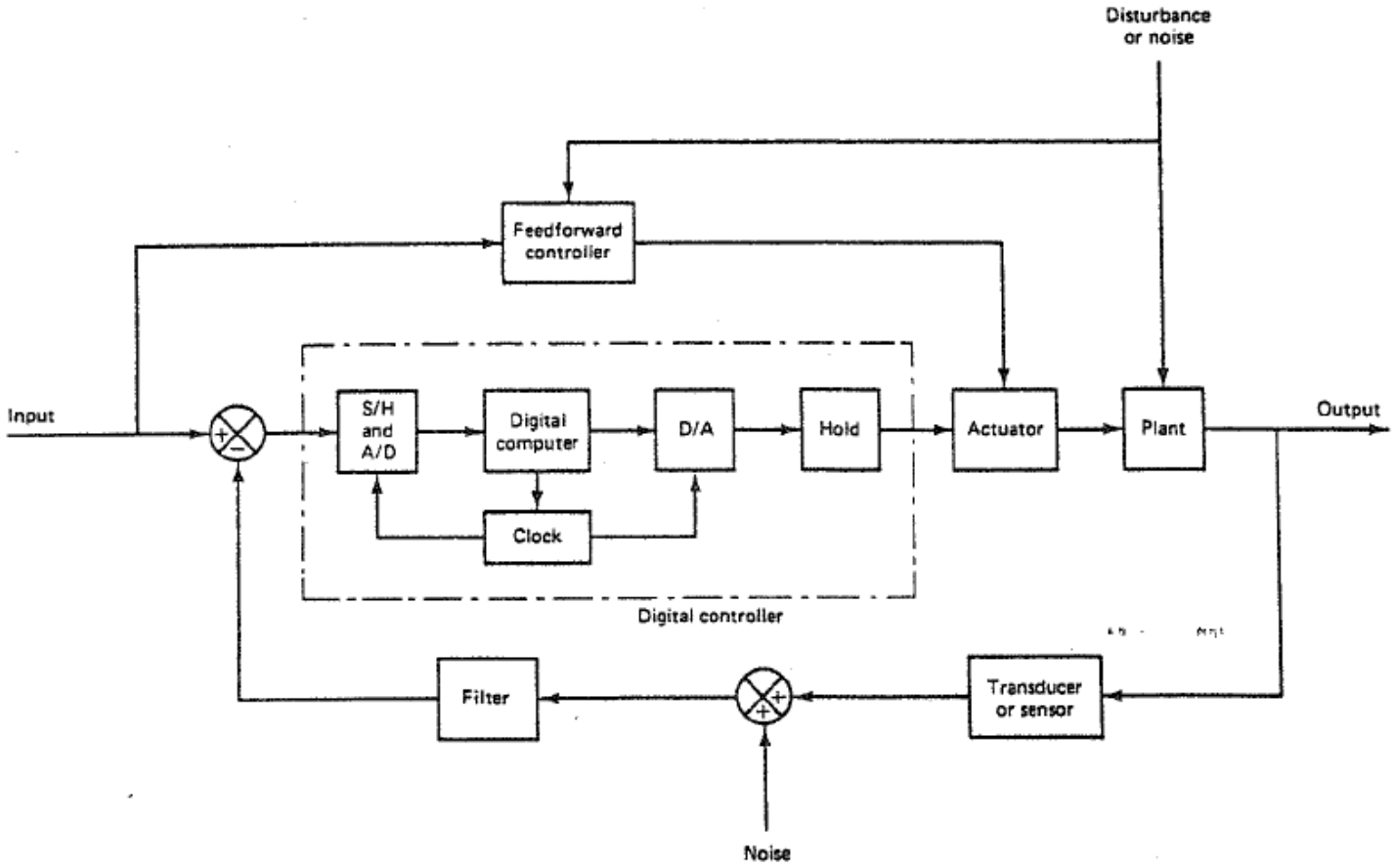
v. PDP-1 in 1959, $$$$, PDP-8 offered in 1965. $

vi. Honeywell 16 Series, a digital controls computer from 1968

vii. Micro-electronics advanced in the years beyond 1970, (Z80)

viii. 8086,80286..Pentium ..

III. Digital control systems



Digital control systems block diagram

III. Digital control systems

i. Definitions
   i. Sample and hold (S/H)
   ii. Analog to digital converter (A/D)
   iii. Digital to analog converter (D/A)
   iv. Plant or process
   v. Transducer

III. Digital control systems

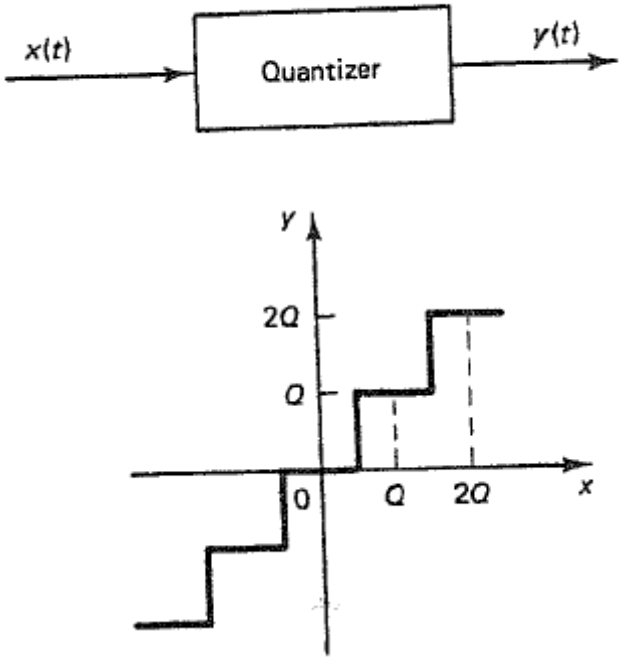
i. Sampling operations
   i. Periodic sampling
   ii. Multiple order sampling
   iii. Multiple rate sampling
   iv. Random sampling

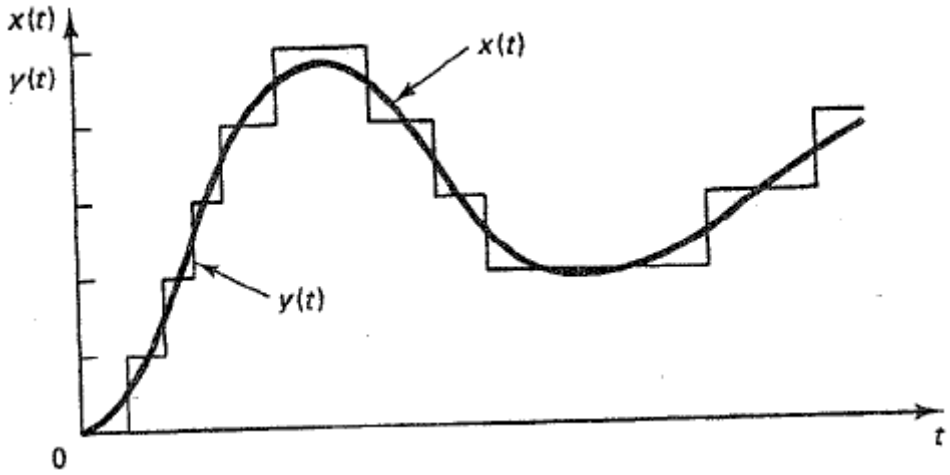
IV. Quantizing and quantization error

i. Quantizing
   i. $Q = \frac{FSR}{2^n}$ Q is the quantization level, FSR is full scale region
   ii. MSB, LSB,
ii. Quantization error $|error| < \frac{1}{2}Q$
   i. Finite bits result finite resolution

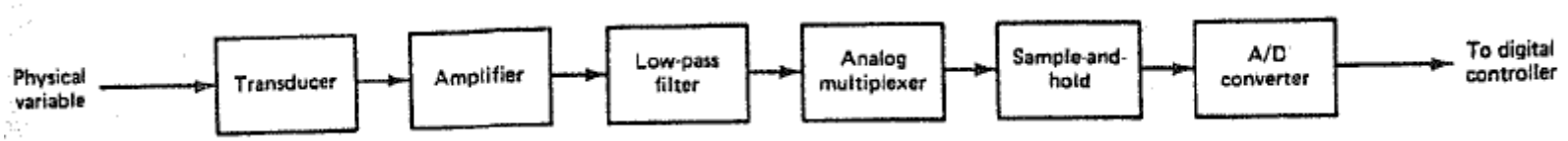
IV. Quantizing and quantization error

i. Quantizing figures

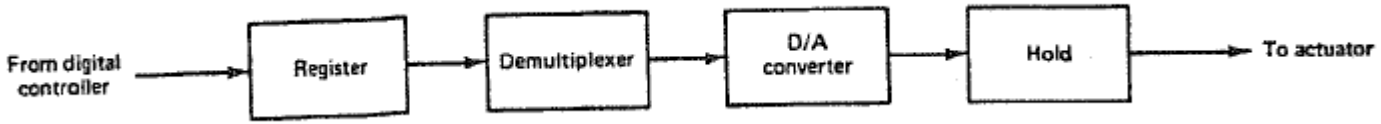




V. Data acquisition and distribution



Block diagram of data acquisition



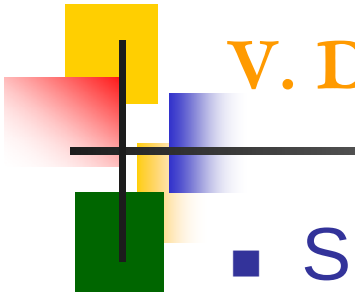
Block diagram of and distribution

V. Data acquisition and distribution

- Why use Data converters
  - **A to D:**

    Digital display, easy to read
    Digital filter
    Digital communication
    Save into computer, etc.
  - **D to A:**

    Output such as audio and video
    Control signal etc

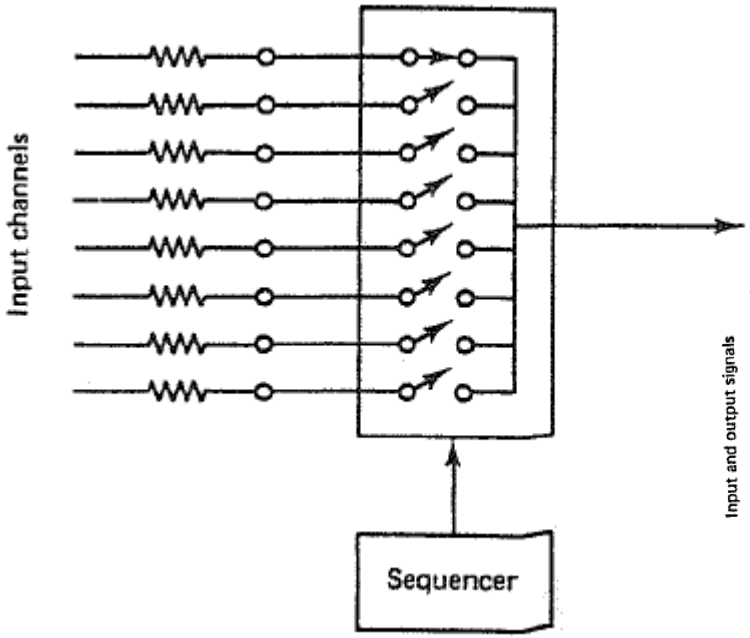


V. Data acquisition and distribution

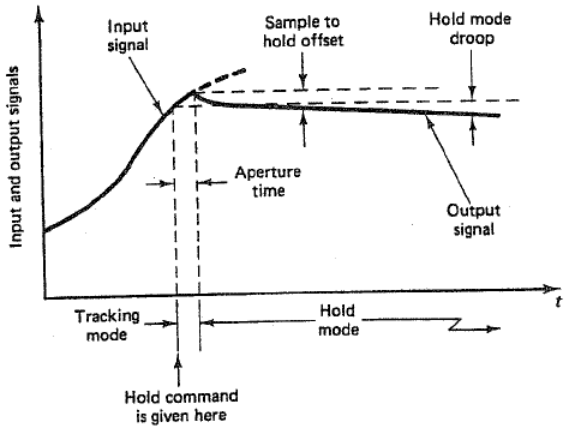
- Signal conversion
  - Multiplexing and demultiplexing
  - Sample and hold
  - Analog to digital conversion (quantizing and encoding)
  - Digital to analog conversion (decoding)

V. Data acquisition and distribution

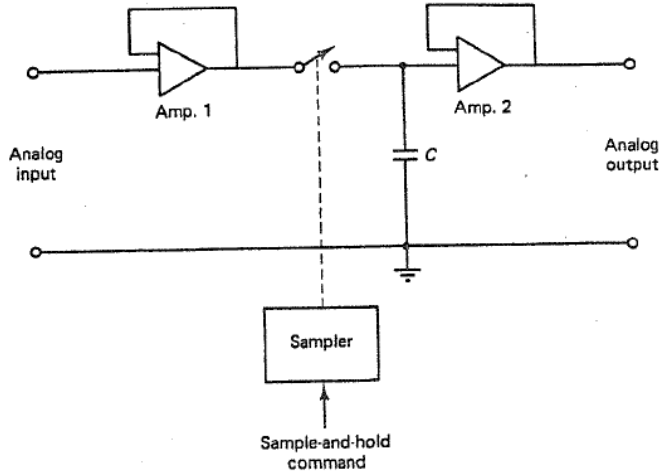
- Signal conversion figures



Analog Multiplexer



Tracking and Hold



Sample and Hold

V. Data acquisition and distribution

- Four types common A/D circuits
  - Successive approximation type
  - Feedback type
  - Parallel type
  - Dual-slope A/D converter
  - Charge-Redistribution converter
- Main factors of A/D circuits
  - Speed
  - Accuracy
  - Size
  - Cost

V. Data acquisition and distribution

D/A circuits