3.10 Mechatronic System Design

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Preview

- The general guidelines for Design were provided in the previous sequences.

- In this sequence, An Integrated Design approach will be presented for mechatronics.
Mechatronics

- Mechatronics can be defined as the analysis, design, and integration of mechanics with electronics through intelligent computer control.

- Mechatronics system engineering has gained much recognition and importance in the industrial world.
Mechatronic Systems

- Signal Conditioning
- A/D
- Micro-Controller
- D/A
- Driver
- Sensors
- Mechanical System
- Actuators
Mechatronic System Design

I. Define the objective and specifications

II. Analyze and Design

III. Build and Test
I. Define Objectives and Specifications

- It is essential for to clearly identify the problem at hand and set the system specifications.

- After the problem is stated
  - Several solutions should be proposed
  - Each alternative should be studied
  - One solution should emerge
II. Analyze and Design

- Establish general block diagram and flow chart.
- Specify the needed inputs and outputs of the system
- Choose the appropriate sensors and actuators.
- Divide work into three parallel design tasks:
  1. Mechanical
  2. Electronic
  3. Software
- Choose the Controller
- Mathematical Modeling
- Simulation
Sensors and Actuators Selection

**Sensors**
- Temperature
- Pressure
- Flow
- Level
- Speed
- Position

**Actuators**
- Electrical
  - Relay
  - AC Motors
  - DC Motors
- Pneumatic
- Hydraulic
Synergistic Design

System Design

Mechanical Design

Electronics Design

Software / Control Design

Design Integration

Interface

Interface
Controller System Selection

- The design of mechatronic systems involves the choice of the controller.

- This is arguably the most critical decision in the design process.

- A comparison among the four main controller groups are explained to the students:
  - Programmable Logic Controllers (PLC)
  - Microcontrollers
  - Digital Signal Processors (DSP)
  - Computers
Controller Algorithm Selection

- Another critical decision that the designer must make is the type of control algorithm to use.

- A comparison among the most-common controller algorithms are explained to the students:
  - On-Off control
  - PID control
  - Intelligent control
III. Build and Test

- This is a time consuming task and will require many troubleshooting steps.

- All lab testing and measurements taken should be well documented.

- Any variation between the hand calculations, simulation, and practical results should be identified and explained.

- The final result is a working prototype.
Crane Model
Robot Manipulator

Control Circuit

Three Cylinders

Valves
CNC Machine
Conclusion

- Mechatronics systems combine the integration of different subsystems: mechanical, electronics, and computer

- The design of mechatronic systems should include a synergistic approach