ME 6401: Overview of Mechatronics

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ME 6401: Advanced Mechatronics
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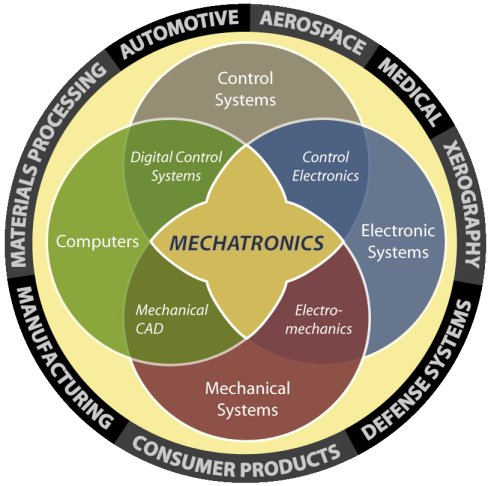
Mechatronics

- The portmanteau Mechatronics was first coined by Mr. Tetsuro Mori, a senior engineer of the Japanese company Yaskawa, in 1969.
- Mechatronics is the synergistic combination of precision mechanical engineering, electronic control and systems thinking in the design of products and manufacturing processes [1].
- Mechatronics is a *methodology*[2] used for the optimal design of electromechanical products.

[1] *IEEE/ASME Transactions on Mechatronics*
[2] a methodology is a collection of practises, procedures, and rules used by those who work in a particular branch of knowledge.

Mechatronics Constituents



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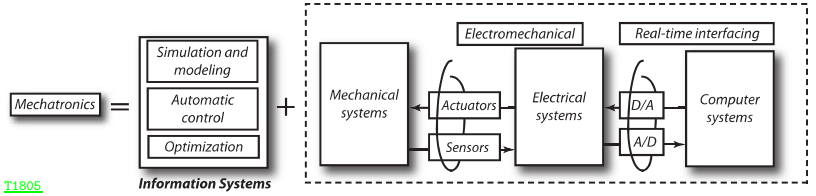
Mechatronics Key Elements



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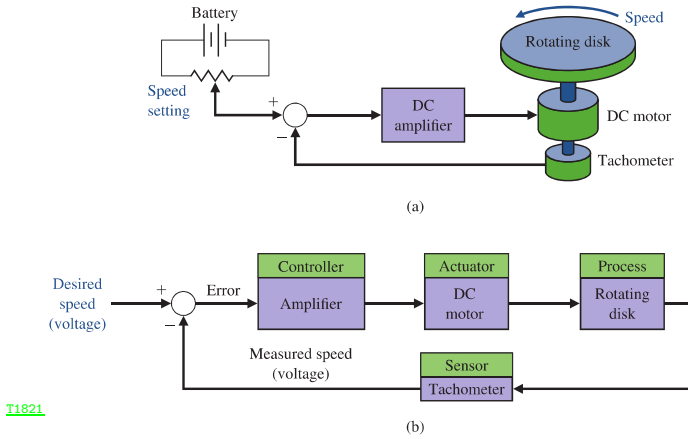
A mechatronic system is not an electromechanical system but is more than a control system.

Simulation and Modelling

- Modelling is the process of representing the behaviour of a real system by a collection of mathematical equations and logic.
- Models are broadly categorised as:
  - Static – no energy transfer.
  - Dynamic – considers energy flow, causes motion, heat transfer and other phenomenon that changes with time.
- Simulation is the process of solving the model and is performed on computer.
- Simulation process has the three basic steps:
  1. Initialisation
  2. Iteration
  3. Termination.

Feedback Control Application



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Automatic Control

Advantages:

- Increased productivity and lower product cost.
- Better and more uniform product quality.
- Greater safety for operating personnel.

Basic Components:

1. The process
2. The measurement system
3. The error-detecting mechanism
4. The controller
5. The final control element.

Optimisation

- In mechatronics, optimisation is primarily used to establish the optimal system configuration. It solves the problem of distributing limiting resources throughout a system such that the pre-specified aspects of its behaviour is satisfied.
- In general, resources are referred to as design variables, aspects of system behaviour as objectives, and system governing relationships (equations and logic) as constrains.
- Example - for a box-shaped luggage to maximise volume:

  Design variables: L (length), W (width), H (height)
  Objective: Maximise V = V(L,W,H)
  Constraints: System relationship V = LHW
  H < 100 mm, W > 50 mm etc.

Integrated Design Issues in Mechatronics

- Mechatronics approach is intended to cause the developers, from the outset, to consider all elements of the product life-cycle from conception through disposal, including quality, cost, schedule, and user requirements.
- Important life cycle factors are:
  - Delivery - time, cost and medium
  - Reliability - failure rate, materials and tolerances
  - Maintainability - modular design
  - Serviceability - on board diagnostics, prognostics and modular design
  - Upgradability - future compatibility with current design
  - Disposability - recycling and disposal of hazardous material.