Tishk International University

Introduction To Mechatronics System

(ME 109) 2023-2024 Fall Term

INSTRUCTOR: AHMED AMEER ARSALAN

EMAIL: AHMED.AMEERARSALAN@TIU.EDU.IQ

Outline

- Assessments
- What is Mechatronics?
- Google Apps
- Microsoft Apps
- Project
- References

Assessment

- Presentation: 10%
- Quizzes & Assignments: 15%
- Class Participation: 10%
- Midterm Exam: 25%
- Final Exam: 40%

What is Mechatronics

- The term "mechatronics" was first assigned by Mr. Tetsuro Mori, a senior engineer of the Japanese company Yaskawa, in 1969. Mechatronics basically refers to mechanical electronic systems

  A synergistic combination of mechanical, electrical, electronics, computer and control systems which, when combined, make possible the generation of simple, more economic, and reliable systems.

  Following figure1.1 shows definition and applications area of mechatronics

What is Mechatronics

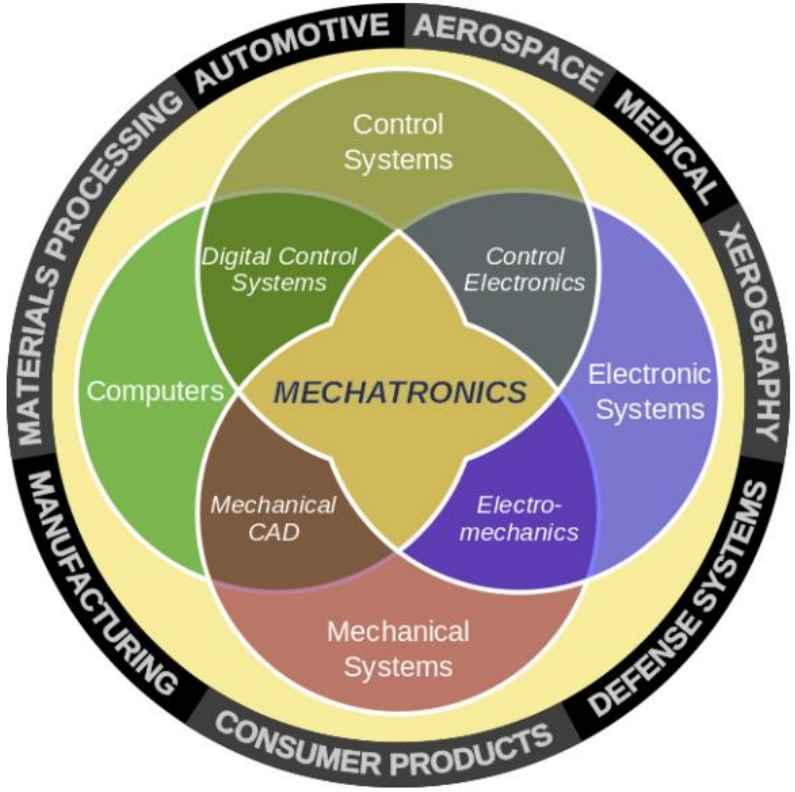
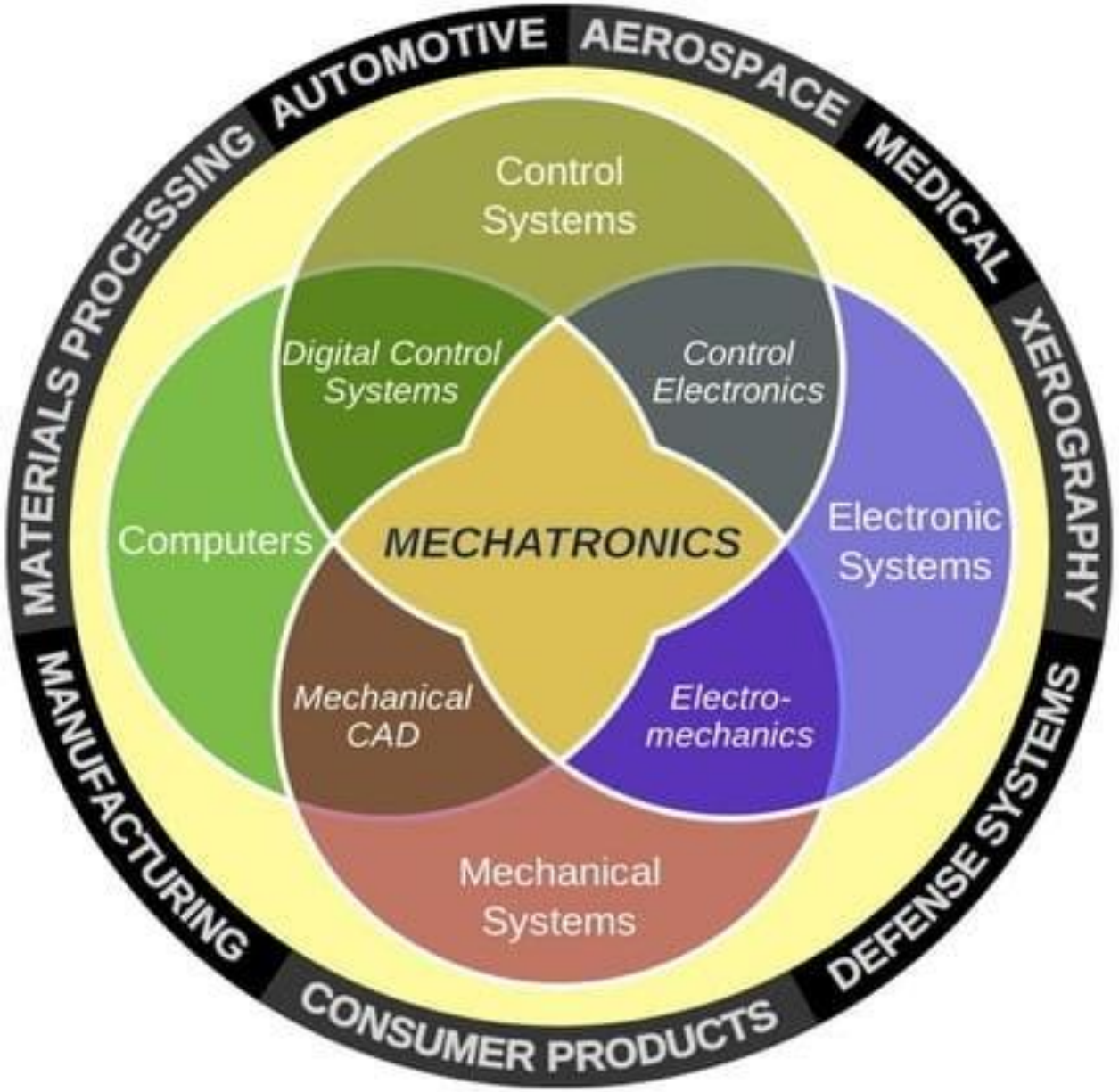
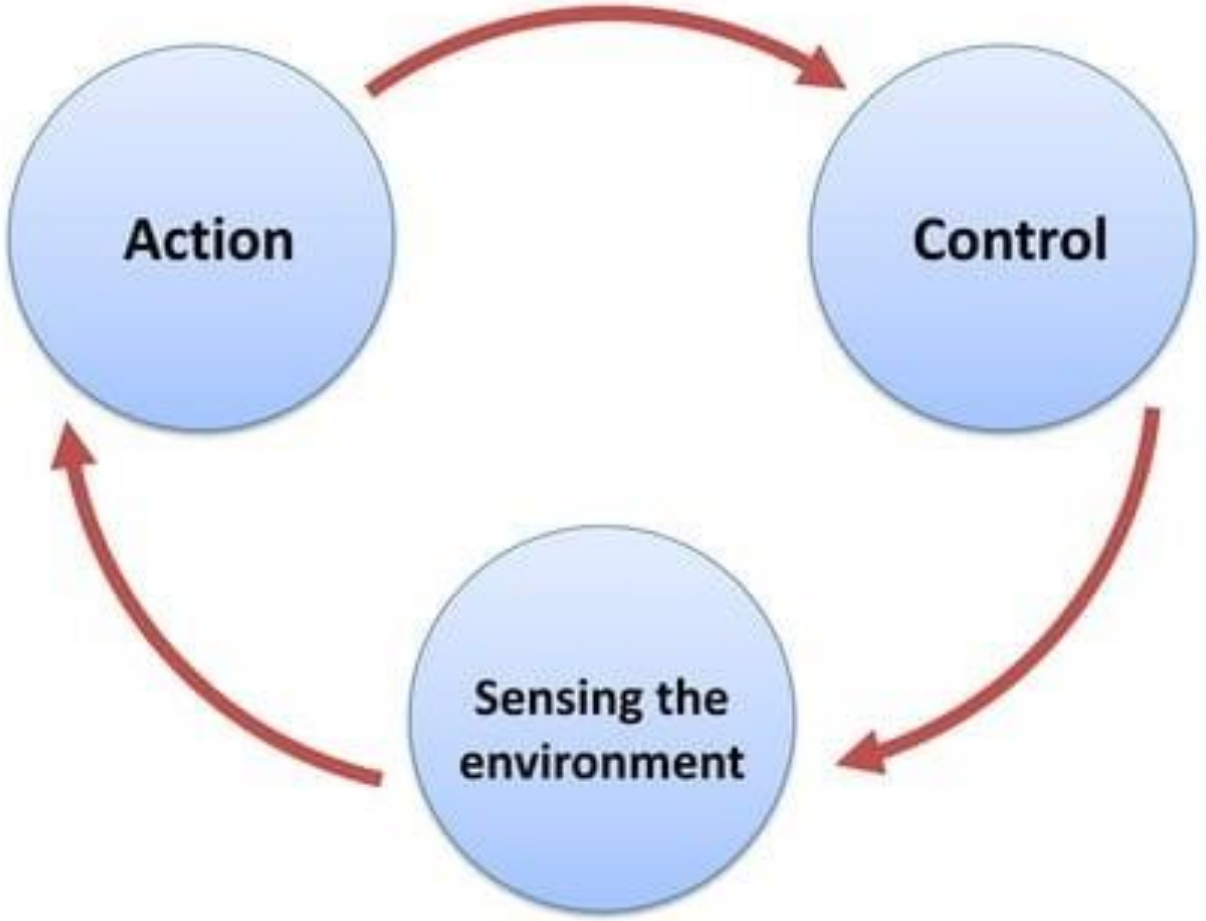


Figure Applications of mechatronics


AUTOMOTIVE
AEROSPACE
MEDICAL
XEROGRAPHY
DEFENSE SYSTEMS
CONSUMER PRODUCTS
MANUFACTURING
MATERIALS PROCESSING
Control Systems
Digital Control Systems
Control Electronics
Computers
MECHATRONICS
Electronic Systems
Mechanical CAD
Electro-mechanics
Mechanical Systems

Model of a Typical Mechatronic System



Modules of a Mechatronic System

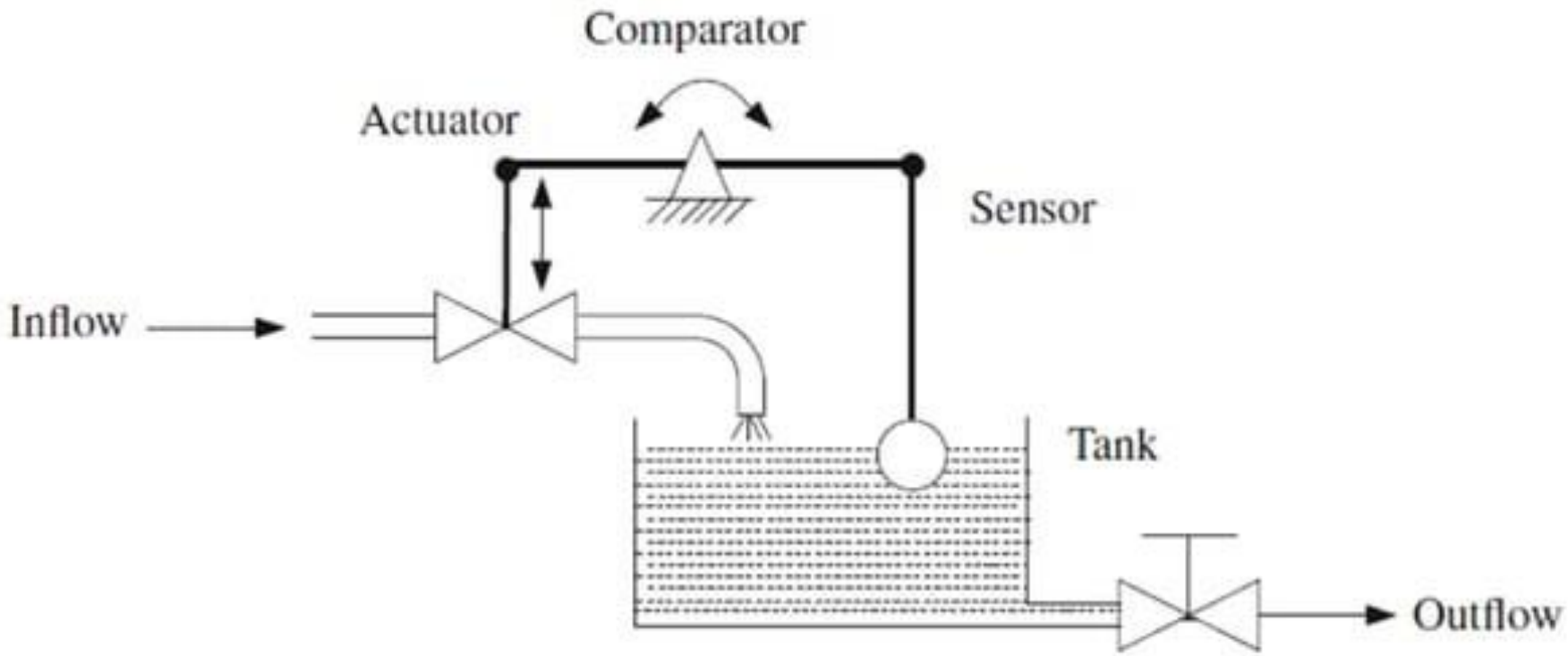
1. Sensing
    I. Sensors
    II. Signal Conditioning
    III. Analog-to-Digital and Digital-to-Analog Conversion

2. Control
    I. Open Loop and Closed Loop Control

3. Action
    I. Drive Circuits
    II. Actuators
    III. Motors

Components of a Mechatronic System

- Mechanical
- Electronics
- Sensors
- Actuators
- Control
- Computing


Comparator
Actuator
Sensor
Inflow
Tank
Outflow

Introduction to Mechatronics

- A mechatronic system has at its core a **mechanical system** which needs to be commanded or controlled by a **controller**.
- The controller needs information about the state of the system. This information is obtained from **sensors**.
- In many cases, the signals produced by the sensors are not in a form ready to be read by the controller and need some signal conditioning operations performed on them.
- The conditioned, sensed signals are then converted to a digital form by **Analog-to-Digital Convertor (ADC)** and are then sent to the controller.

Introduction to Mechatronics

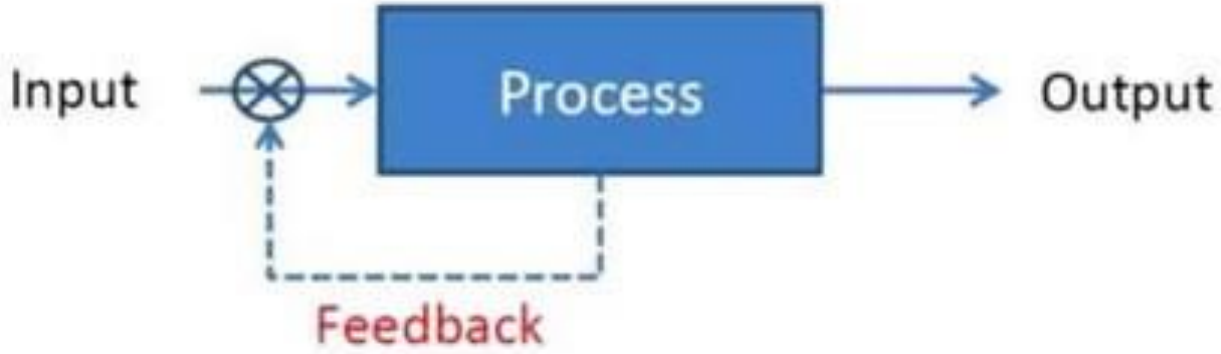
- The controller is the 'mind' of the mechatronic system, which processes user commands and sensed signals to generate command signals to be sent to the **actuators** in the system. Actuators are devices that can convert electrical energy to mechanical energy
- The user commands are obtained from a variety of devices, including command buttons, graphical user interfaces (GUIs), touch screens, or pads.

Introduction to Mechatronics

- In some cases, the command signals are sent to the actuators without utilizing any feedback information from the sensors. This is called open-loop system, and for it to work, this requires a good calibration between the input and output of the system.
- The more common mode of operation is the closed-loop mode in which the command signals sent to the actuators utilize the feedback information from the sensors. This mode of operation does not require calibration information.

Open Loop System

Closed-Loop System



Introduction to Mechatronics

- Every computer controlled system has four basic functional blocks:

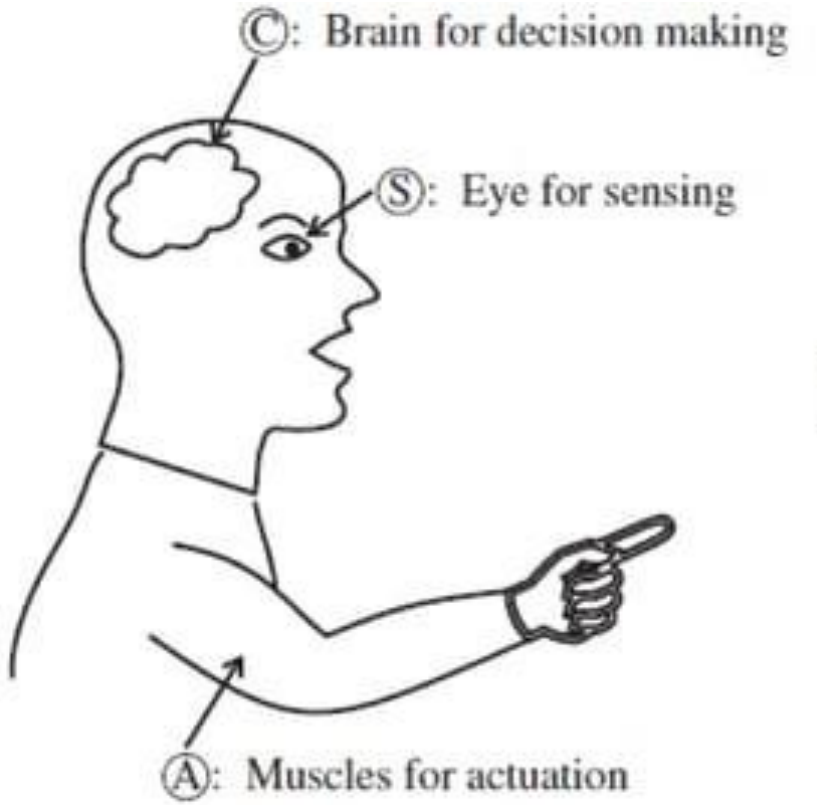
1. A process to be controlled
2. Sensors
3. Actuators
4. Controller

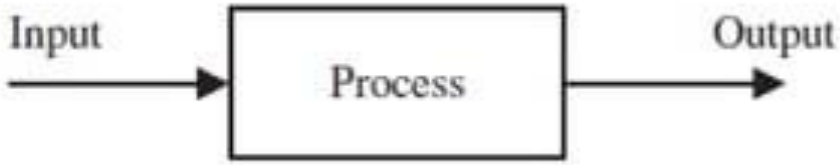
Introduction to Mechatronics

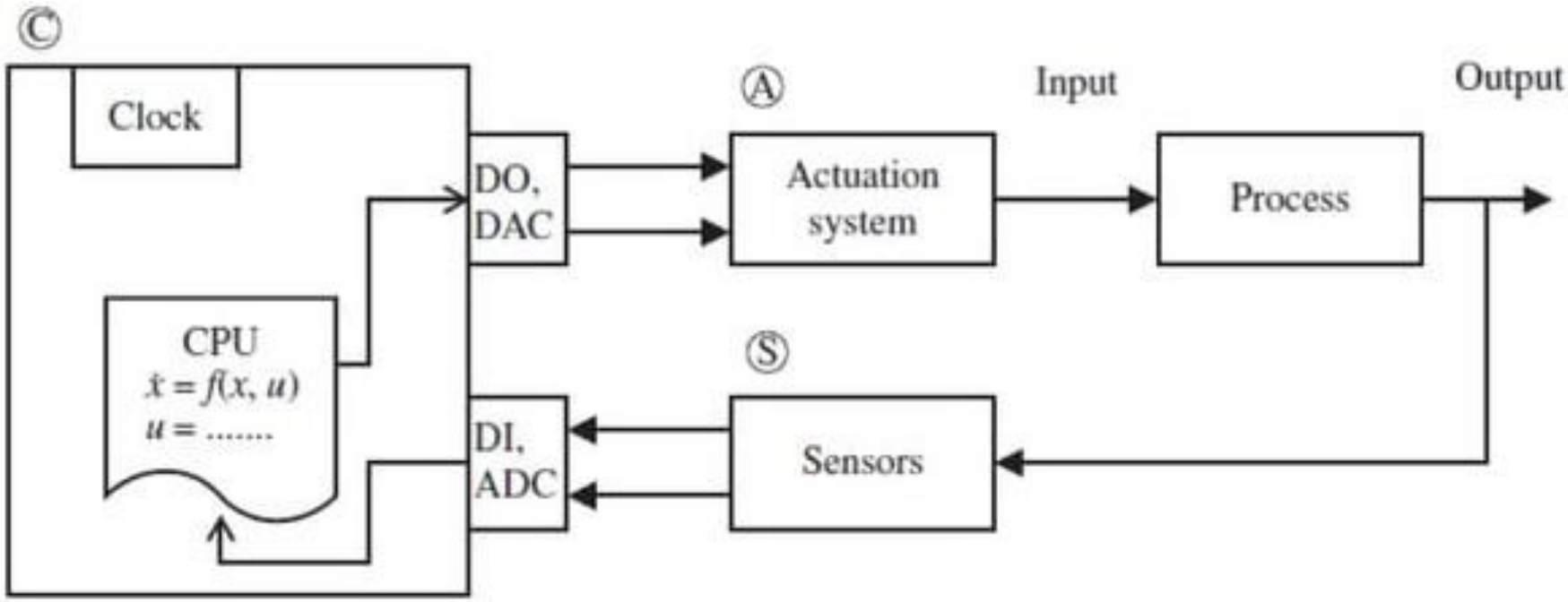
- The analogy between a human controlled system and computer control system is shown in figure.
- If a process is controlled and powered by a human operator, the operator observes the behavior of the system (i.e. using visual observation), then makes a decision regarding what action to take, then using his muscular power takes a particular control action.
- One could view the outcome of the decision making process as a control or decision signal, and the action of the muscles as the actuator signal which is the amplified version of the control (or decision) signal.

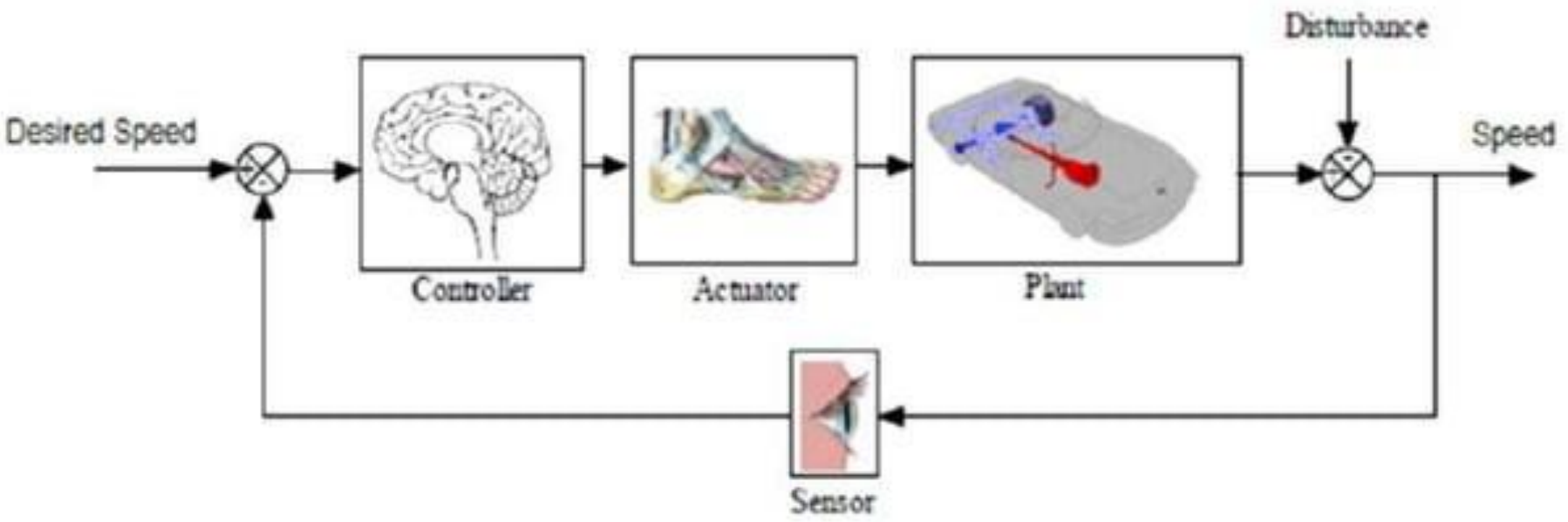
Introduction to Mechatronics

- The same functionalities of a control system can be automated by use of a digital computer as shown in the figure.
- The sensors replace the eyes, the actuators replace the muscles, and the computer replaces the human brain.
- Every mechatronic system has some sensors to measure the status of the process variables.
- The sensors are the “eyes” of a computer controlled system.
- Actuators are the “muscles” of a computer controlled system.


Ⓒ: Brain for decision making
Ⓢ: Eye for sensing
Ⓐ: Muscles for actuation


Input
Process
Output


©
Clock
CPU
$\dot{x} = f(x, u)$
$u =$ .....
DO,
DAC
DI,
ADC
Ⓐ
Actuation
system
Input
Process
Output
Ⓢ
Sensors



Vehicle Speed Control

Examples of Mechatronic Systems

- Antilock Brake System (ABS)
- Electronic Fuel Injection (EFI)
- Traction Control System (TCS)
- Adaptive Cruise Control (ACC)
- Automatic Camera
- Scanner
- Hard Disk Drive
- Industrial Robots
- Mobile Robots (Wheeled Robots, Legged Robots)

Examples of Mechatronic Systems

Wheeled Robots

Examples of Mechatronic Systems

Aerial Robots

Examples of Mechatronic Systems

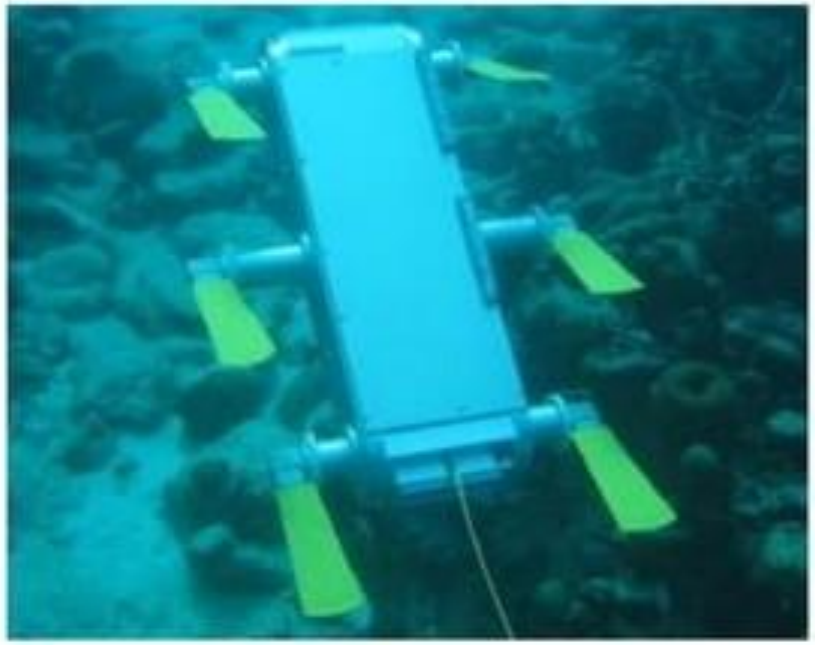
Legged Robots

Examples of Mechatronic Systems

Autonomous Cars

Examples of Mechatronic Systems

Hard Drives



Underwater Robots

Examples of Mechatronic Systems

Industrial Robots

What is the difference between Email and Message?

Official Email

Dear [Recipient's Name],

I hope this email finds you well.

[Opening Sentence: Briefly state the purpose of your email or a courteous greeting.]

[Body of the Email: Provide the necessary details or information concisely. Break it down into paragraphs if discussing multiple points. Use bullet points if appropriate for clarity.]

[Closing Statement: Express gratitude if necessary, or provide any necessary next steps or additional information.]

[Closing Greeting: "Sincerely," "Best Regards," "Thank You," etc.]

[Your Name] [Your Job Title, if applicable] [Your Contact Information: Phone number, email address, etc.]

Google Apps

Google apps

- Google Drive
- Google Doc
- Google Sheet
- Google Slides
- Google Forms

Microsoft Apps

Google apps

- Microsoft Word
- Microsoft PowerPoint
- Microsoft Excel

Project

Robotic Arm as a Mechatronic System:

Click here to see the video

Project

1. Programming:

- Software controlling the system's behavior and functionality.
- Algorithm development for task execution and motion planning.
- Integration of control algorithms into the microcontroller/PLC.

Project

2. Controller:

- Microcontroller/PLC: Brain of the system, processing sensor data and sending commands to actuators.

- Control Algorithms: PID controllers or other control strategies for accurate movement and manipulation.

Project

3. Sensors:

   - Position Sensors: Encoders to detect joint angles.

   - Force/Torque Sensors: Measure forces applied during tasks.

   - Vision Systems: Cameras or depth sensors for object recognition.

Project

4. Actuators:

- Electric Motors: Stepper or servo motors for precise movements.

- Pneumatic/Hydraulic Actuators: For heavy lifting or forceful actions.

Project

5. Power Supply:

   - Power Electronics: Converters and drivers to power actuators.

   - Batteries or Power Sources: Supply energy to the system.

6. Gears and Mechanical Components:

   - Gear Systems: To control and transfer torque efficiently.

   - Linkages and Joints: Mechanisms allowing multi-axis movement.

Functionality:

- **Object Recognition:** The vision system identifies objects to manipulate.

- **Sensor Fusion:** Data from position, force, and vision sensors is integrated for precise control.

- **Control Algorithms:** The controller interprets sensor data and calculates movements, ensuring accuracy and safety.

- **Actuation:** Motors and actuators are driven based on controller commands, moving the robotic arm accurately.

- **Feedback Loop:** Constant feedback from sensors adjusts the arm's movements in real-time.

Application:

Such a mechatronic system could be employed in various industries:

- **Manufacturing:** Assembling products in industries like automotive or electronics.

- **Healthcare:** Assisting in surgeries for precision and dexterity.

- **Warehouse Automation:** Sorting, picking, and packing goods.

References

Book Reference: "Mechatronics: Principles and Applications" by Godfrey Onwubolu

This comprehensive book covers the fundamental principles of mechatronics, including electronics, mechanics, control systems, and integration. It provides a practical approach to understanding mechatronics and its applications in various industries.

Academic Paper: "Introduction to Mechatronics and Measurement Systems" by David G. Alciatore and Michael B. Histand

This academic paper provides an in-depth introduction to mechatronics, focusing on measurement systems, sensors, actuators, signal processing, and control systems. It offers a theoretical foundation and practical examples for students and researchers.

Online Resource: "Introduction to Mechatronics" by Coursera (offered by the National Research Tomsk Polytechnic University)

Coursera offers an online course providing an introductory overview of mechatronics, covering the integration of mechanical, electrical, and computer engineering. It includes video lectures, quizzes, and hands-on projects to enhance understanding.