Mechatronics — An Introduction to Mechatronics

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Abstract

Innovation in today’s Industrial system or industrial control system (ICS) is often only possible due to the embedded system. Particularly, the software connects previously isolated systems resulting in, so-called, advanced mechatronic systems. Mechatronics is an interdisciplinary way of combining the classical engineering disciplines for mechanical and electrical engineering, electronic engineering and computer science. The word, Mechatronics is composed of mechanics from mechanics and electronics from electronics. In other words, technologies and developed products will be incorporating electronics more and more into mechanisms, intimately and organically, and making it impossible to tell where one ends and the other begins.

Field of study involving the analysis, design, synthesis, and selection of systemsthat combine electronics and mechanical components with modern controls and microprocessors

Keywords

Mechatronics system, Mechatronics Definitions, Mechatronics Design Step, Objectives of Mechatronics.

1. INTRODUCTION

The word Mechatronics was first introduced by the senior engineer of a Japanese company, Yaskawa, in 1969. The company was granted trademark rights on the word in 1971. The word soon received broad acceptance in industry and, in order to allow its free use, Yaskawa decided to abandon his rights on the word in 1982. The Mechatronics systems consist of components from different physical domains, which are closely coupled and therefore interact with one another. Moreover, the behavior of the components is highly non-linear.

2. WHAT IS MECHATRONICS?

Today it means mechatronics engineering activities including designing, testing and operation of machinery and equipment, in which there is a high level of functional integration of mechanical systems with electronics and computer control.
Mechatronics is an interdisciplinary field, combining in a synergistic manner the classical knowledge of mechanical engineering, hydraulics, pneumatics, electronics, optics and computer science. A typical mechatronic system picks up signals from the environment, processes them to generate output signals, transforming them for example into forces, motions and actions. The aim of Mechatronics is to improve the functionality of technical systems and the creation of new concepts of machinery and equipment with built-in "artificial intelligence".

Mechatronics provides an opportunity, not only humanization of machines, but also it changes the mindset and the approach to technological issues and most importantly teaching new technologies and ways of acquiring knowledge and skills. The most important feature of mechatronic devices is the ability to process and communicate information accurately in a form of different types of signals (mechanical, electrical, hydraulic, pneumatic, optical, chemical, biological), with high level of automation of these devices.

![Mechatronics System](image)

Nowadays a lot of machines and even simple household appliance consist of mechanisms driven by motors and actuators with electrical control circuits. The overall control of these machines is done by programmable components like PLC’s, micro-controllers or even PC’s. The major difference between conventional machinery with electronic components and mechatronic machinery is that the former adds electronic components, while the latter integrates electronic components. Adding some electronics to a machine means adding additional functions, and integrating electronics means furnishing extended capability to the machinery.

3. Mechatronics Definitions

Mechatronics is the synergistic integration of sensors, actuators, signal conditioning, power electronics, decision and control algorithms, and computer hardware and software to manage complexity, uncertainty, and communication in engineered systems. IEEE (Institute of Electrical and Electronics Engineers) and ASME (American Society Mechanical Engineers) promote the following definition: “Mechatronics is the synergistic integration of mechanical engineering with the electronic control and the intelligent, PC-based control, in the design and manufacturing of goods and processes.”

4. Objectives Of Mechatronics

Mechatronics has mainly the objective to improve technical properties, i.e., to make machines work faster and to make manufacturing cheaper. In industry, products and processes are designed from scratch, and therefore they are known, and dealing with them is a kind of straightforward action where the behavior can be predicted, at least in principle. Even there, however, the complexity of tasks and situations is increasing, leading already
to the use of unconventional tools like fuzzy control, neural networks, expert systems, and their combinations. Figure shown the mechatronics industry system

5. Mechatronics Design Step

Mechatronic products are commonly used in industry and everyday life. Designing of mechatronic products requires dedicated approach that takes into account: interdisciplinary design, market related constraints, multifunctionality, user-friendly operation and demand of minimization of the cost of the whole product operation period. Thus designers who create mechatronic products should possess comprehensive interdisciplinary knowledge, ability to co-operate in an interdisciplinary designing team as well as team management skills, and knowledge how to use the up-to-date tools of computer aided engineering. Additionally the know-how in scheduling and carrying out prototyping of mechatronic systems is very useful.

6. Type of Elements

Electromechanical elements: -

Sensors, A variety of physical variables can be measured using sensors. Actuators, DC servomotor, stepper motor, relay, solenoid, speaker, light emitting diode (LED), shape memory alloy, electromagnet, and pump apply commanded action on physical process. IC-based sensors and actuators digital-compass, potentiometer, etc.

Electrical elements: -

Electrical components e.g., resistor (R), capacitor (C), inductor (L), transformer, etc

Electronic elements: -

Analog/digital electronics, transistors, thyristors, opto-isolators, operational amplifiers, power electronics, and signal conditioning.

Control interface /computing hardware elements: -

Analog-to-digital (A2D) converter, digital-to-analog (D2A) converter, digital input/output (I/O), counters, timers,
microprocessor, microcontroller, data-acquisition and control (DAC) board, and digital signal processing (DSP) board

**Computer/Information System:**

Computer elements refer to hardware/software utilized to perform, computer-aided dynamic system analysis, optimization, design, and simulation, virtual instrumentation, rapid control prototyping, hardware-in-the-loop simulation, PC-based data acquisition and control

**Elements of Mechatronics:**


Mechatronics is the result of applying information systems to physical systems. The physical system, the rightmost dotted block, consists of mechanical, electrical, and computer (electronic) systems as well as actuators, sensors, and real-time interfacing. Sensors and actuators are used to transduce energy from high power, usually the mechanical side, to low power, the electrical and computer or electronic side. The block labeled mechanical systems frequently consists of more than just mechanical components and may include fluid, pneumatic, thermal, acoustic, chemical, and other disciplines as well.

### 7. New Research Challenges

These interactively cooperating, intelligent machines lead to new research topics in the control techniques of mechatronics and in other areas as well. It will be important that a machine and its components have learning capabilities, self-adaptation and self-calibration. Techniques such as the combination of neural networks, and fuzzy control with expert systems will further emphasize the importance of software.

**Fig: - Elements of Mechatronics**

Mechatronic Engineering is the engineering discipline concerned with the research, design, implementation and maintenance of intelligent engineered products and processes enabled by the integration of mechanical, electronic, computer, and software engineering technologies. Specific expertise areas can include:

- Artificial Intelligence Techniques
- Avionics Computer Hardware and Systems Control Systems
- Data Communications and Networks
- Dynamics of Machines and Mechanisms
- Electromagnetic Energy Conversion
- Electronics
- Embedded & Real-time Systems
- Fluid Power and other Actuation Devices
- Human-Machine Interface Engineering and Ergonomics
- Industrial Automation
- Measurement, Instrumentation and Sensors
- Mechanical Design and Material Selection
8. Mechatronics In Medicine

In 1985 the Department of Mechanical Engineering at Imperial College began research into medical robotics for neurosurgery. Further research into a robot for prostatectomy, commencing in 1988 culminated, in 1991, in a "World First" with the demonstration of robotic prostate surgery. This robot was the first to actively remove tissue from a human patient in an operating theatre. With the expansion of robotic surgery applications, the Mechatronics in Medicine Laboratory was set up in 1993, as part of the Computer Aided Systems Engineering Section, to research and develop mechatronic aids to surgery. The group has developed mechatronic applications in fields as diverse as neurosurgery, magnetic resonance imaging (MRI) compatible robotics, haptic training systems for surgeons, urological surgery and orthopaedics, high intensity focused ultrasound and blood sampling.

9. New Applications


10. References


