A ROLE OF MECHANICAL ENGINEERING IN MECHATRONICS

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Annotation: In this article we have discussed the role of Mechanical Engineering both in education and practice of Mechatronics. In particular we have outlined main features of the mechatronic systems as strongly related with mechanical engineering when one considers that generally a task of a system is devoted to operation with interaction with environment or human beings.

Keywords: Mechatronics, Education, Mechanical Engineering, Integration, mechatronic design, manipulator, actuator

Introduction

Mechatronics has been established since 1990’s as a multidisciplinary Engineering dealing with the complexity nature of modern systems. As shown in Fig.1 Mechatronics is understood as a fusion of the disciplines Mechanics, Electronics, Electric Engineering, Control, Measurement, and Computer Science.

A mechatronics system is, indeed, composed of mechanical parts, electric devices, electronics components, sensors, hardware and it is operated and controlled under the supervisions and commands that are programmed through suitable software.

Thus, main characteristics of mechatronics systems are the integration and complementarities of the several aspects from the many disciplines that describe the design and operation of the components and overall system. In addition, for a suitable operation of a mechatronic system engineering issues and human-system aspects must be considered as looking at features and constraints from the environment within a system operates, the design by which it has been developed, the operation performance through which it fulfil the task, and the production by which it has been built.

Main part

Thus, summarizing the Mechatronics in a modern Engineering multidisciplinary vision for modern integrated systems that are more and more conceived as a combination of parts with different natures both in design and operation.

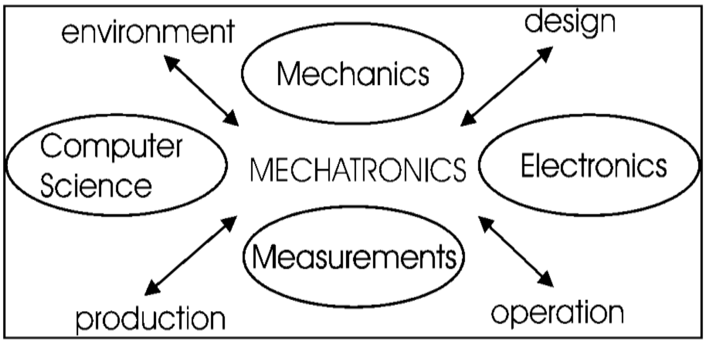

Fig 1. A scheme for definition of Mechatronics

In Table 1-Illustrative examples of revolution of systems to mechatronic designs

	Mechanics % 1960-2000	Electronics & Informatics % 1960-2000
CAR	90-50	10-50
CALCULATOR	100-10	0-90
CAMERA	100-30	0-70

Cars, whose aim is transportation, were built essentially with mechanical components in the past, but increasing performance and speed has required regulation and control of motors with sophisticated systems. Even inside comfort and safety have improved by using sensored equipment with more and more mechatronic designs so that today a car can be understood as a full mechatronic design, being pure mechanical designs limited to less than 50% of the system.

Cameras were conceived and built as pure mechanical design since the photo task did not require any motion of parts. Today regulated operations, like zooming, and even photo creation, are obtained with electronics components and the only mechanical parts are left for interaction with human operators, like command buttons.

Calculators have evolved even more deeply and the complicated pure mechanical systems that were conceived since 18-th century are completely disappeared and today only informatics and electronic hardware are used for calculators up to 100% of parts. The only mechanical parts with pure mechanical operations are the key buttons in the keyboards for being pushed by fingers of a human user.

The above-mentioned aspects are summarized in the schemes in Figs.2 and 3as concerning with a general layout and model for a mechatronic design as related to a servo-controlled actuator.

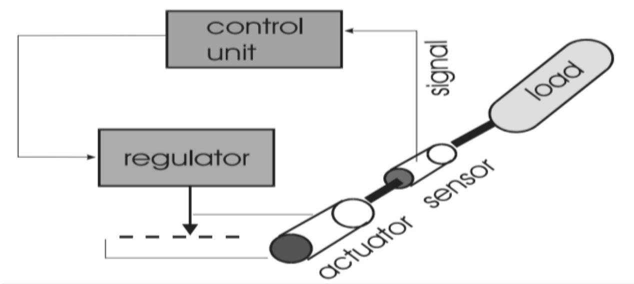

Fig.2 A mechatronic design for a manipulator actuator

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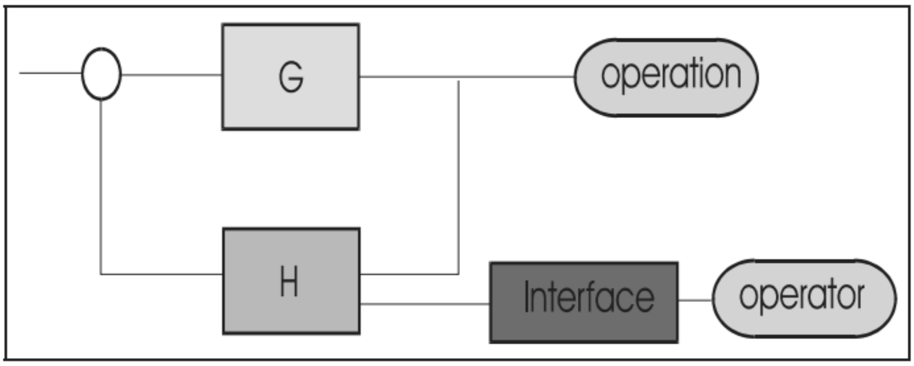

Fig.3 A block diagram for mechatronic actuation

In Fig.2 an actuation system is shown with its basic components: actuator, sensor, control unit, and a regulator device. The operation of the system is controlled through a suitable programming that allows the control unit to receive and elaborate signals from sensors and then to send command signals to regulator for operating the actuator. The task is modelled by a load indicating both a payload and its movement according to the final goal of the system. The components in Fig,.2 correspond to the fields of disciplines that are indicated in Fig.1 even without any sophistication. This is because today systems are always conceived, designed and regulated to achieve optimal performance by using a mechatronic design.

In Fig.3 a block diagram is shown to model the operation of the system in Fig.2 both for simulation/design and control purposes. G function models the system behaviour, mainly from mechanical viewpoint by taking into account also sensor signals. H is a control function that is formulated by using the mechatronic design to regulate the system operation at suitable required levels of performance. Although the scheme is directed to certain autonomy of the system, human operators always interact with the system through definition and check of the operation and even through overlooking the system by means of suitable interfaces both for starting and updating system operation.

As already mentioned, mechanical nature of system goal is of fundamental importance for the system success and must be considered both in terms of load characteristics and operation performance, and by considering the action and supervision of human operators, as synthetically shown in Figs.2 and 3.

Thus, an optimal operation of mechatronic systems requires both at level of design stages and operation managements that all components are fully understood and their integration is exploited by running the components at similar levels of their capabilities. This requires a suitable knowledge of the different engineering disciplines pertaining to the several fields of technology for the several areas in Fig.1. Thus, formation and practice for Mechatronics must be thought since the first stages of engineering curricula in order to have engineers ready in a suitable short time for professional activity and capable to handle successfully mechatronics systems even for innovation.

The multidisciplinary character of Mechatronics requires a differentiation of roles in practicing and experts engineers. Practicing engineers should be able to operate and/or adapt mechatronic systems in given application fields. Expert engineers should have capability to make innovation both in mechatronic systems and their applications.

These two levels of competence refer to different level of formation: a short term with practice capabilities and a long term with design and innovation capabilities.

MECHANICAL ISSUES

A mechatronic system can be characterized synthetically by versatility and flexibility as two main aspects whose integration gives mechatronic behaviour of modern systems.

Versatility is mainly related to operation capability and performance that are needed for mechanical activity of a mechatronic system. Flexibility is mainly related to regulation capability and performance that are needed for controlled actions of a mechatronics system.

Thus, mechanical issues in mechatronic systems are related to versatility mainly in terms of Kinematics and Dynamics of a load movement, Mechanics of interactions (like contact and grasp), Dynamics of Multibody Systems. However, the mechanical attention is always linked to aspects of the mechatronic design and indeed, simulation of mechanical actions is usually performed by taking into account also models for the controlled actuation.

Thus, the role of Mechanical Engineering in Mechatronics can be understood according to two main aspects, namely the mechanical design and operation, and the mechanical interaction with environment in performing system tasks.

Those mechanical aspects both for design and operation aims are studied by looking at traditional disciplines for machinery but even at specific novel disciplines.

Thus, Kinematics and Dynamics of load movement are studied to analyse and investigate on the motion of mechatronic systems and load body during the operation performing or not a task.

Particular attention is usually directed to mechanical aspects of the motion in the system and load as due to the flexibility and control of the operation of the system. In addition the task is studied by looking both at kinematic and dynamic features of the motion and related actions against the environment and within the mechatronic system yet. The particular attention to motion issues is also motivated by the attention to safety and security issues both for the system and human operators that can be in the operation area of the system.

Mechanics of interaction is interesting in evaluating situations with echanical contacts and force transmissions between the system parts or its extremity and environment or task object. It is fundamental to size the system actions according to the task requirements and specific analysis of the corresponding mechanics is necessary to achieve desired goalsand proper working of the overall system.

Dynamics of Multibody systems is a mechanical discipline that is oriented to consider complex systems during complex motions like spatial movement at high acceleration and velocity, with the aim to take into account any inertia effect. Indeed, this discipline has been developed by looking at integrated systems and very often the dynamics of Multibody systems include uitable modelling of components of other nature than pure mechanical one, like for example servo-controlled actuators whose motion and dynamics can strongly affect the system behaviour and operation characteristics, as it is mechatronic systems.

Besides the above-mentioned topics, mechanical issues in mechatronic systems can be considered for specific goals and operation tasks, like for example locomotion mobility, object grasping and manipulation, force transmission, and so on.

Versatility of a mechatronic system can be seen and understood under different aspects, and the above-mentioned considerations can be related to main aspects which make the role of Mechanical Engineering fundamental for the success of the mechatronic systems, but within a frame of multidisciplinary integration yet.

REFERENCES

1. Грабченко А.И., Клепиков В.Б., Доброскок В.Л., Введение в мехатронику. Харьков, 2014.
2. Alciatore D.G., Histand M.B. (2002), “Introduction to mechatronics & Measurement Systems”, McGraw-Hill Professional, 2002.
3. Necsulescu D (2002)., “Mechatronics”, Prentice Hall, 2002.
4. Auslander D.M., Kempf C.J. , “Mechatronics - Mechanical System Interfacing”, Prentice Hall, 1995.
5. Ю.В.Подураев, Мехатроника: Основы, Методы, Применение: Москва, «Машиностроение».: 2007;
6. Егоров О.Д., Подураев Ю.В. Конструирование мехатронных модулей: Учебник. - М.: ИЦ МГТУ "СТАНКИН", 2004.