International Journal of Enhanced Research in Educational Development (IJERED)
ISSN: 2320-8708, Vol. 11 Issue 1, Jan-Feb, 2023, Impact Factor: 7.326

An Overview of Mechatronics Systems

Shreya Mane

Research Fellow, Department of Research and Development, Astroex Research Association, Deoria-274001, India

ABSTRACT

Despite widespread interest in mechatronics education, there is no consensus on what mechatronics is, how it should be taught, or at what grade level. The main difficulty for mechatronics course designers is to strike the right balance between breadth and depth while giving students the chance to practice integration.In this paper, the terms "mechatronics" and "mechatronics philosophy" are defined along with the characteristics of mechatronics systems and products. It examines a few elements of mechatronics education and training and contrasts generalist and specialist engineering as two alternative approaches to engineering education. Additionally, it provides a global overview of mechatronics education in higher education institutions, with a focus on a typical mechatronics engineering degree program. A discipline-based mechatronics engineer will be more in demand in the future, the study's conclusion states.

Keywords: Mechatronics, engineering design, robotics system

INTRODUCTION

In many instances, conventional combinational design philosophies are proving insufficient for the sophisticated goods and quick turnaround times required by today's markets. Many times, a company's mechanical and electronic design departments are located in different cities or even nations. If they happen to be in the same building, their lack of interaction will unavoidably have an impact on product design.A machine is frequently designed by a mechanical engineer, who then throws it over the wall to an electrical or electronic engineer to fit the control systems and, in turn, to a software engineer to develop the control programs. Better engineering products can be designed using the trans-disciplinary method known as mechatronics, which is built on open communication networks and concurrent activities.

Traditional automated manufacturing systems lack the adaptability that is heavily mandated by contemporary trends in the production of commodities, and thus are unable to adjust quickly to changes in demand and supply [1]. According to the conventional method, the mechanical, electrical, electronic, and software parts that make up these multi-technology systems are designed individually, end-to-end, and then merged to form the finished system.

There is currently no agreed definition of what mechatronics actually is. The terms micromechatronics, optomechatronics, supermechatronics, mecanoinformatics, contromechanics, and megatronics are just a few of the many that have been used in various contexts to describe concepts related to or including mechatronics. The following are some examples of attempts to define mechatronics.

- The field of mechatronics includes the expertise and technological advancements necessary for the flexible creation of controlled motions [2].
- Mechatronics, which encompasses control systems and numerical methods used to build things with built-in intelligence, is the synergistic fusion of mechanical and electrical engineering, computer science, and information technology [3].
- The field of mechatronics is new and evolving quickly, thus a precise definition is neither attainable nor particularly desirable, according to Hewit in [4]. A definition that is too rigid would be restricting and limiting, and that is exactly the opposite of what is desired at this time.

As an interdisciplinary discipline, mechatronics frequently draws contributions from all linked fields without really highlighting the benefits and difficulties brought on by the interdisciplinary interactions. As an illustration, numerous mechatronics conferences have lacked focus, which has prevented the best contributions from being received, despite the fact that they exist. This has the drawback of impeding mechatronics' advancement as an engineering science. There are still not many scientific publications in mechatronics, which could assist the field become more specialized.

MECHATRONICS PHILOSOPHY

There are various definitions of mechatronics. There are actually as many definitions as there are professionals in the area. It could be argued that the definition's semantics are irrelevant. Most people would agree that mechatronics is an interdisciplinary field that combines mechanics, electronics, and information technology to provide improved goods, services, and systems. At the system or product design stage, it integrates the traditional disciplines of mechanical engineering, electronic engineering, and computer science/information technology. Mechatronics, which emphasizes the need for integration and close interaction across many areas of engineering, is thus not a new branch of engineering but rather a recently evolved idea.

The name "mechatronics," which combines the words "mechanics" and "electronics," obviously identifies the main fields of study. This should not be interpreted literally as defining the boundaries of mechatronics; rather, mocha should be understood to encompass all aspects of microelectronics and information technology, including control, while tronics should be understood to encompass the broadest aspects of the physical embodiments of mechanical engineering, including optical elements.

The majority of engineered items or processes involve moving parts, which necessitate precise manipulation and control of their dynamic structures. Technology enablers including sensors, actuators, software, communications, optics, electronics, structural mechanics, and control engineering may be used in this. The integration of microelectronics and information technology into mechanical systems in order to achieve the optimal outcome is a crucial component of the mechatronics philosophy. Therefore, rather than being the result of an interdisciplinary effort, the design of such products and processes must take into account other variables, such as suitability.Mechatronics thus challenges conventional engineering thought since choosing the methods to the intended functional outcomes necessitates bridging the gap between conventional engineering disciplines. The Mechatronic Philosophy's detractors claim that it is " "with a simple system engineeringposh new name ". By looking at instances where mechatronic designs have replaced goods that were previously engineered utilizing a systems approach, with a corresponding cost savings of appreciable proportions, this may be easily disproved [5].

MECHATRONICS PRODUCTS AND SYSTEMS

A typical mechatronic system gathers signals, analyses them, and produces forces and motions as an output. Sensors, microprocessors, and controls are integrated into and added to mechanical systems. Such a system differs significantly from traditional machines and mechanical systems in that it uses sensors to detect environmental or parametric changes and then, after properly processing the information, responds to them. Examples of common mechatronics goods include robots, digitally controlled engines, automated guided vehicles, electronic cameras, telefax machines, and photocopiers.

[6] lists the following features of mechatronic products and systems: Functional interaction between mechanical, electronic, and information technologies; spatial integration of subsystems in a single physical unit; intelligence associated with the control functions of the mechatronic system; flexibility, the ease with which mechatronic products can be modified to fit changing requirements and situations; multifunctionality associated with the software defined functions of the microprocessor; invisible functions, carried out by microelectronics and information technology. and technological reliance, which are strongly related to the industrial technologies available.

DEFINING MECHATRONICS

"In essence, mechatronics is just good design practice. The fundamental concept is to use additional controls to get more performance out of a mechanical equipment." It entails enhancing the performance and adaptability of products and processes through the use of cutting-edge, affordable technology. The use of computer and controls technologies frequently results in a design solution that is more elegant than the use of only mechanical means. Design flexibility is increased and outcomes are enhanced by having a solid understanding of what may be accomplished without the use of mechanical means.

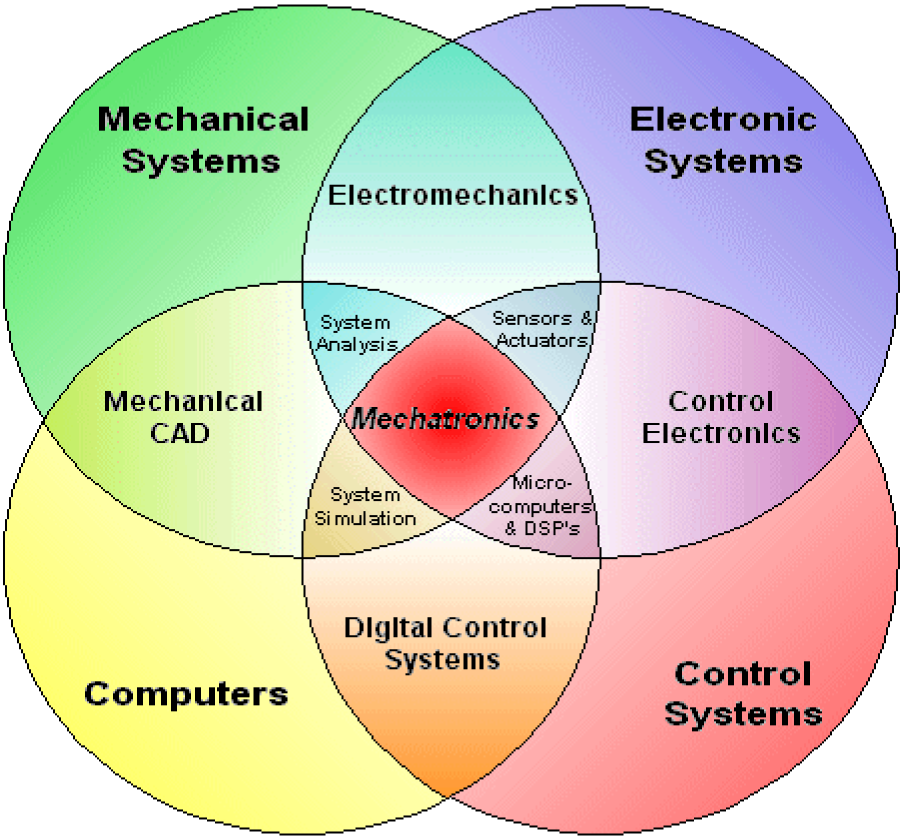

Fig 1.Illustration of mechatronics is where mechanics, electronics, computers, and controls intersect

THE TRADITIONAL MECHATRONICS APPROACH

A large variety of industry areas, including automotive, manufacturing systems, aircraft control, construction equipment, etc., have well-established mechatronic engineering fields. Mechatronics is often approached using a subsystem-based approach in such engineering. Subsystem-based product development refers to a method of creating integrated systems from technologically similar subsystems (mechanics, electronics, control and software). Concurrently created, the subsystems place a significant emphasis on their interactions. Each subsystem is then designed in a pretty conventional manner after the interfaces are created. This indicates that the emphasis has been on team building to enhance communication and multidisciplinary understanding between engineers with various levels of experience in order to correctly define the interfaces.

Due to a technology's closer integration with other technologies under the subsystem-based approach, there is no practical need to create that technology; for example, automated control and computer science are closely integrated. Instead, the mechatronic system's performance is just the product of sound technological integration. The subsystem-based approach is also completely prevalent in the engineering literature that is now available on mechatronics, although there is insufficient coverage of the development process and accompanying team building. The first chapter in books of this literature is typically devoted to defining or explaining what mechatronics is, with the remaining chapters covering each topic in a conventional but condensed manner (modeling, sensors, actuators, control, computer hardware, interfaces, communication, etc.) [7, 8].

With the development of digital electronics, it is now possible to design or enhance systems that depend on mechanical parts to carry out their intended dynamic actions. Mechanical engineering, software engineering, control engineering, and computer engineering are the main disciplines that must be studied concurrently and in an integrated manner. Although the end-effecting components are still mechanical, the main paradigm change made possible by mechatronics is the transfer of functionality from mechanical hardware to computer software.

With regard to how (i.e., with which technology and with which partitioning) specific functionality is achieved, there is now more flexibility in mechatronics design. The characteristics of transfer functions, data flows, and energy transfer are determined by the choice of how functionality is implemented. There are few opportunities to take implementation features into account to further enhance the design because decisions about functionality partitioning and associated implementation technology are taken early in the design chain.Theories, models, and methods that make it easier to model, analyze, synthesize, simulate, and prototype multitechnological systems—of which mechatronic systems are a key example—are urgently needed in order to better the current situation. In theory, this will result in a development strategy that uses less bottom-up, ad hoc design and more conceptual, top-down design.

Over the past few decades, numerous new mechatronic curricula and courses have been created. The most typical trend is that mechanical engineering programs and courses are where mechatronic programs and courses originate. The mechanical engineering curriculum now includes or incorporates courses in electrical engineering, computer science, and control engineering. Rarely do electrical engineering or computer science degrees incorporate mechanical engineering to provide a mechatronics focus. Interdisciplinary education also involves the addition of new courses to an already-existing curriculum or the custom-tailored creation of an entirely new curriculum.

Mechatronics Research

We argue that mechatronics as an engineering discipline should concentrate on multidisciplinary interactions as opposed to the subsystem-based strategy we previously described. On the basis of these interactions, we will find, formulate, and carry out new research. As a result, mechatronics plays a crucial role in bridging the gaps between related engineering specialties. As a result, restrictions brought on by these gaps become clear. This has the effect of assisting in the identification of new research topics in several fields through the application of a mechatronics and hence multidisciplinary approach.A useful interpretation of this is that mechatronic science is the creation and development of new theories, models, concepts, and tools in response to needs emerging from interacting scientific disciplines, whereas mechatronic engineering is about mastering a variety of disciplines, technologies, and their integration/interaction.

Mechatronics System Design Concentration Area Compatibility with Existing Programs

With mechanical, electrical, computers, controls, and industrial safety, mechatronics has been named as one of the industry-sector technological competencies [9]. Products and processes that use mechatronics are becoming more commonplace in a variety of businesses, on equipment used in research, and even in day-to-day activities. Printers, ATMs, cash deposit machines, vending machines, packaging machines, cameras, servo systems, ABS brake systems, fuzzy logic dishwashing machines, video recorders, CD players, mine detection robots, airplane autopilot systems, medical devices, weapons, etc. are some examples of mechatronic products.

Mechatronic System Integration

The interdisciplinarity is one reason why integrating sophisticated systems, such computer-controlled mechanical systems, is challenging. Modular mechanical design, real-time systems, software architectures, software engineering, control engineering, and electronics design and packaging are only a few of the techniques needed for mechatronic systems integration. Therefore, a multidisciplinary environment of a particular critical scale is the only environment in which a general framework and systematic rules for systems integration can be established. For systems integration research to be truly beneficial from an industrial perspective, operational systems should be the focus.

The following are fundamental research questions pertaining to the integration of mechatronic systems.

- Design techniques for robust distributed real-time computer control systems (synthesis and analysis).
- scalable control, software, hardware, and mechanical designs built on good theoretical foundations. Such architectures ought to enable scalable integration of hardware, software, and control functions.
- Control structures for mechanical systems of extraordinary complexity. The integration of various control paradigms (such as model-based and behavior-based) in the face of a wide range of control objectives and potentially competing controllers is a particular problem in this situation.

The Language of Mechatronics

While each subject area has its own "language" to describe its actions, this cannot be said of mechatronics, which as part of its communication role must take the domain-specific terminology and integrate them across disciplines. The issue is further complicated by the existence of what may be described as a number of mechatronic "dialects," depending on the situation or subject under discussion. This means that depending on which dialects are being spoken by the parties involved, there is a chance for misunderstandings even within the mechatronics community.

CONCLUSION

Given the variety of approaches and emphases present within the community, mechatronics has historically experienced an identity crisis both inside the academic community and outside of it. This is likely to continue. However, there is also a demand for graduate engineers who have the specific integration abilities that come with a mechatronic upbringing and education. Therefore, finding the right balance between in-depth knowledge and the capacity to operate in an integrating role in a variety of situations is a problem for mechatronics course designers.We have cited a number of fields that have benefited from an interdisciplinary outlook and a concentration on cross-disciplinary connections. We think there are numerous additional such fields, such as dependability, architectures, and development tools. These domains do contain certain discipline-specific procedures and techniques, but once more, by examining the relationships across the disciplines, it is possible to determine where existing theories and methodologies overlap and where they fall short. As an engineering science, mechatronics has a responsibility to further the existing state of the art in complex mechatronic system design through such integrated research activities.

The future mechatronic engineer is a unique professional who has the ability to work beyond the borders of constituent disciplines to find and use the appropriate combination of technologies that will offer the best solution to the challenge at hand. Additionally, he or she should be able to collaborate with and lead a design team that may include both specialists and generalists in engineering.

REFERENCES

[1]. G. Rzevski, “On conceptual design of intelligent mechatronic systems,” Mechatronics 13(2003), 1029-1044.
[2]. H. van Brussel, “The mechatronics approach to motion control,” in Proc. Int. Conf. on Motion Control the Mechatronics Approach, Antwerp, Belgium, Oct. 1989.
[3]. D. Shetty and R.A. Kolk, Mechatronics System Design. PWS Publishing Company, 1997.
[4]. F. Meyer-Kramer, “Science-based technologies and interdisciplinarity: Challenges for firms and policy,” in Systems of Innovation, Technologies, Institutions and Organizations, C. Edquist (ed.). London: Pinter, 1997, pp. 298-317.
[5]. R. M. Parkin, "What is this thing called mechatronics? " Inaugural Professorial Lecture, University of Technology, Loughborough, May 4, 1994.
[6]. J. Buur, “Mechatronics design in Japan,” Institute for Engineering Design, Technical University of Denmark, 1989.
[7]. D. Shetty and R.A. Kolk, Mechatronics System Design. PWS Publishing Company, 1997.
[8]. W. Bolton, Mechatronics Electronic Control Systems in Mechanical Engineering. Longman Scientific & Technical, 1995.
[9]. P. M. M. I. "Mechatronics Competency Model.”. N.p., 3 Sep 2012. Web. 5 Apr 2013.