Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 765 – 769
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4245

Modern Prospects for the Application of Mechatronics and Robotics Capabilities

Aydin Aliyev[1], Abdulkadir Yalchinkaya[2]

Abstract

This article explores the application of mechatronics and robotics capabilities. In recent years a new quickly developing scientific and technical activity was created. It is called Mechatronics and represents an innovative field of science and equipment where the high-precision mechanics connects to the same exact electronics under control of the most modern computer programs [1],[2]. As a result difficult mechanisms of computer motion control with tremendous functionality are created. Industrial robots are striking examples of such mechanisms. Besides, there are mechanisms of retracting plane flaps and the chassis, many systems of a modern car and "smart houses". Technical and technological progress is impossible without mechatronics [3],[4]. Robotics and industrial automatic equipment in various branches of economy, automation of technological processes, systems of planning and business management, automation of transport, dispatching and other systems falls within the scope of its interests. Nowadays "Mechatronics" is one of the most demanded educational majors in the world. Mechatronics specialists are demanded in different areas: in power engineering, machine-tool design and production of the equipment, automation of technological processes, robotics and automotive industry. Security systems, military equipment, the medical equipment can't be designed without mechatronics.

Keywords: *Mechatronics, Roboticists, Engineering, Programming language, Computer.*

Introduction

Mechatronics is the combination of mechanical engineering, electronic engineering, and software engineering. Mechatronics means the synergistic use of precision engineering, control theory, computer science, sensor and actuator technology to design improved products and processes. The word Mechatronics was first coined in Japan over 40 years ago. Since then, mechatronics has been used to represent a synergistic blend of mechanics and electronics. It's a significant design trend that has a great influence on the product-development process, international competition in manufactured goods, and the nature of mechanical engineering education in coming years.

Mechatronics is a methodology for designing products with better, more precise characteristics. These characteristics can be achieved by considering not only the mechanical design but also the use of servo controls, sensors, and electronics. It is also very important to make the design robust. Computer disk drives, for example, are a prime example of the successful application of mechatronics.

Mechatronics is the combination of traditional design methods with sensors and instrumentation technology, actuator technology, embedded real-time microprocessor systems, and real-time software. Mechatronic products exhibit certain distinguishing features, including the replacement of many mechanical functions with electronic ones, which results in much greater flexibility and easy redesign or reprogramming. The basic idea is to apply new controls to extract new levels of performance from a mechanical device. It means using modern, costeffective technology to improve product performance and flexibility. In many cases, the application of computer and controls technology provides a design solution that is more elegant than the purely mechanical approach.

[1] Baku State University, Department of Computational Mathematics, Baku, Azerbaijan, Western Caspian University, Department of Information Technologies, Baku, Azerbaijan, National Aviation Academy, Department of Computer Systems and Programming, Baku, Azerbaijan.
E-mail: aydin_aliyev66@mail.ru.
[2] Student at secondary school No. 244 in Baku, Republic of Azerbaijan, winner of many international robotics Olympiads.

Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 765 – 769
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4245

The Traditional Mechatronics Approach

Engineering of mechatronic systems and products is well established in a substantial number of industrial branches like automotive, manufacturing systems, aircraft control,construction equipment, etc. Such engineering typically applies a subsystem-based approach to mechatronics. By subsystem based we refer to a product development strategy by which integrated systems are built from technology homogeneous subsystems (mechanics, electronics, control and software).

The subsystems are developed in a concurrent manner with an important focus on subsystem interfaces. Once the interfaces are designed, each subsystem is designed in a fairly traditional way. This means that the focus has been on team building to improve communication and multidisciplinary understanding between engineers of different expertise such that the interfaces can be properly defined. In the subsystem-based approach there is no real demand on development of a certain technology as a result of its closer integration with other technologies; e.g., the close

integration of automatic control and computer science.The performance of the mechatronic system is instead merely a result of a sound integration of existing technology.

Mechatronics and Manufacturing

Engineers from most disciplines will quite understandably associate mechatronics with robotics and factory systems. Systems that move, machine and assemble “hard” substances are really only classifiable as ‘mechatronic’ to the degree that they contain elements of reasoning and agility. Areas of mechatronic involvement in manufacturing include assembly, machining, inspection, dangerous material handling and disassembly. The modern automobile contains many of the same technologies, including allwheel drive and electronically-actuated fuel injection. Automobile assembly plants have led the way in robotic painting, welding and heavy material handling. With the introduction of the ‘make to order’ paradigm, manufacturing is now far more sophisticated than simply mass producing items for inventory. Buyers now want to customize everything and to do so at almost the unit level. This requires operations that were previously unimagined. The pharmaceutical and power generation industries are also heavily dependent on mechatronic devices to provide skilled operations in environments where it is either unsafe or inconvenient for humans to work. This includes the handling of toxic and radioactive materials and maintenance in heavily polluted atmospheric conditions. Automated inspection systems provide 100 % quality control and dramatically outperform humans in such boring and repetitive tasks. While mechatronic systems are an obvious area of interesting research, they are also gaining acceptance and popularity in manufacturing processes and are becoming an integral part of a greener and more sustainable industrial world.

Mechatronics and Education

In the development of mechatronics education, the concern in course design has always been that of achieving an appropriate balance between providing the necessary depth of understanding of core technologies and the ability to develop solutions which integrate those technologies. This may be compared with a subject based approach to engineering education where the emphasis is on ensuring a depth of understanding within the subject area. The education of a mechatronics engineer thus has to place a greater emphasis on the ability to work across and between individual areas of technology. The achievement of a balanced programme of mechatronics education must therefore ensure that individuals are provided with sufficient depth in at least one area of technology in order to allow them to make an effective contribution to that area, whilst ensuring the breadth of understanding necessary to give them credibility in regard to other subject specialists. The key challenge then facing mechatronics course designers is that of ensuring that there is an appropriate balance between depth and breadth within the course, as well as providing opportunities to enable students to practice integration.

Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 765 – 769
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4245

Robotics

Roboticists develop man-made mechanical devices that can move by themselves, whose motion must be modelled, planned, sensed, actuated and controlled, and whose motion behaviour can be influenced by "programming". Robots are called "intelligent" if they succeed in moving in safe interaction with an unstructured environment, while autonomously achieving their specified tasks. This definition implies that a device can only be called a "robot" if it contains a movable mechanism, influenced by sensing, planning, actuation and control components. It does not imply that a minimum number of these components must be implemented in software, or be changeable by the "consumer" who uses the device; for example, the motion behaviour can have been hard-wired into the device by the manufacturer. Robotics is, to a very large extent, all about system integration, achieving a task by an actuated mechanical device, via an "intelligent" integration of components, many of which it shares with other domains, such as systems and control, computer science, character animation, machine design, computer vision, artificial intelligence, cognitive science, biomechanics, etc. In addition, the boundaries of robotics cannot be clearly defined, since also its "core" ideas, concepts and algorithms are being applied in an ever increasing number of "external" applications, and core technology from other domains are becoming crucial components in more and more modern robotic systems. Components of robotic systems The real robot is some mechanical device ("mechanism") that moves around in the environment, and, in doing so, physically interacts with this environment. This interaction involves the exchange of physical energy, in some form or another. Both the robot mechanism and the environment can be the "cause" of the physical interaction through "Actuation", or experience the "effect" of the interaction, which can be measured through "Sensing". Robotics as an integrated system of control interacting with the physical world Sensing and actuation are the physical ports through which the "Controller" of the robot determines the interaction of its mechanical body with the physical world. As mentioned already before, the controller can, in one extreme, consist of software only, but in the other extreme everything can also be implemented in hardware. Within the Controller component, several sub-activities are often identified: Modelling. The input-output relationships of all control components can be derived from information that is stored in a model. This model can have many forms: analytical formulas, empirical look-up tables, fuzzy rules, neural networks, etc. Planning. This is the activity that predicts the outcome of potential actions, and selects the "best" one. Almost by definition, planning can only be done on the basis of some sort of model. Regulation. This component processes the outputs of the sensing and planning components, to generate an actuation setpoint. Again, this regulation activity could or could not rely on some sort of (system) model.

Robot Programming

The computer system that controls the manipulator must be programmed to teach the robot the particular motion sequence and other actions that must be performed in order to complete its task. There are several ways to program industrial robots. One method is called leadthrough programming. The manipulator is driven through the various motions needed to perform a given task; the motions are being recorded into the robot's computer memory. A second method of programming involves the use of a programming language very much like a computer programming language. However, in addition to many of the capabilities of a computer programming language (i.e., data processing, computations, communicating with other computer devices, and decision making), the robot language also includes statements specifically designed for robot control. These capabilities include motion control and input/output. Motion-control commands are used to direct the robot to move its manipulator to some defined position in space. For example, the statement "move P1" might be used to direct the robot to a point in space called P1. Input/output commands are employed to control the receipt of signals from sensors and other devices in the manufacturing cell and to initiate control signals to other parts of equipment in the cell. For instance, the statement "signal 3, on" might be used to turn on a motor in the cell, where the motor is connected to output line 3 in the robot's controller. Robotics and Mechatronics technologies have become essential for developing devices/machines to support human life and society. Examples include assistive devices for elderly and handicapped persons and cooperative robots for workers in factories and automation in unstructured environments, such as construction fields and farms. Several leading international researchers

Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 765 – 769
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4245

and engineers are addressing these trending topics also within several books and conference series such as reported inthe recent publications [5–11].

Advantage of Mechatronic Solution

There are many benefits to a mechatronics solution. They include: 1) precision control; 2) more efficient; 3) more reliable; 4) smaller size. Precision Control Flow rate, speed, position, and any number of other variables can be controlled precisely with a microcontroller. In many applications, purely mechanical solutions are not as efficient, nor as precise as mechatronic solutions. Cruise control in an automobile is a great example of how a mechatronic solution allows for precise control. A microcontroller based solution will factor in many different variables in order to give the car a smooth acceleration to the desired speed as well as maintaining a constant velocity over varying load conditions. More Efficient The efficiency of a system can be improved by adding intelligence to the design. Certain portions of the system can be shut-off when not in use or a microcontroller can make better use of the energy available by offering the precision control described previously. Techniques such as Pulse Width Modulation can be used instead of resistive elements to vary the voltage and current to a load, thereby increasing the efficiency of the system. More reliable Mechanical designs are prone to wear and tear over time. In many situations a mechatronic solution is more reliable. A good example of this is the odometer in your car. Mechanical odometers use a direct drive system that consists of a flexible cable running from the transmission to the odometer gage. The solution is unreliable because the cable is prone to failure. The modern mechatronic solution consists of an optical encoder and digital display, which increases system reliability. Smaller Size Adding a microcontroller to a system may result in space savings. Motor drive circuits, for instance, traditionally had to have over-sized drive stages to handle in-rush current. In-rush current can be limited and the size of the drive stage can be reduced by implementing soft-startup using a microcontroller.

Prospects of Mechatronic Systems

In the future, growth in mechatronic systems will be fueled by the growth in the constituent areas. Advancements in traditional disciplines fuel the growth of mechatronics systems by providing "enabling technologies". For example, the invention of the microprocessor had a profound effect on the redesign of mechanical systems and design of new mechatronics systems. We should expect continued advancements in costeffective microprocessors and microcontrollers, sensor and actuator development enabled by advancements in applications of MEMS, adaptive control methodologies and real-time programming methods, networking and wireless technologies, mature CAE technologies for advanced system modeling, virtual prototyping, and testing. The continued rapid development in these areas will only accelerate the pace of smart product development. The Internet is a technology that, when utilized in combination with wireless technology, may also lead to new mechatronic products. While developments in automotives provide vivid examples of mechatronics development, there are numerous examples of intelligent systems in all walks of life, including smart home appliances such as dishwashers, vacuum cleaners, microwaves, and wireless network enabled devices. In the area of "human-friendly machines", we can expect advances in robot-assisted surgery, and implantable sensors and actuators. Other areas that will benefit from mechatronic advances may include robotics, manufacturing, space technology, and transportation. The future of mechatronics is wide open. When it comes to mechatronics, the sky is the limit as more and more ideas will be developed to improve the way we live and do things. With the ever-changing needs and wants of a complex and sophisticated world, innovations and technologies will have to improve and develop with the rapidly changing times. In the future, mechatronics will increasingly focus on safety, reliability and affordability. Mechatronics will also play a large role in the use of robotics to assist with efficiency, productivity, accountability and control. Robots not only master repetitive and dangerous tasks, but they do it low cost and with lower margins of error. Companies using robotics will have the luxury of keeping work in their own plants rather than exporting it overseas. Mechatronics also is projected to play a major role in the medical field, as well as in computerized world and parts of industry-based manufacturing. Instead of building a computer to run a machine, mechatronics will help make the computer a part of the machine that builds a product. Mechatronics shouldn't change the design process, but rather give the engineer greater knowledge so that concepts can be developed more efficiently; so that communications with other engineering disciplines are improved. Client and market satisfaction are the major goals in the field of

Volume: 3, No: 7, pp. 765 – 769
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4245

mechatronics. Once the needs of a client are expressed, product specifications can be developed from those needs. Then the design process can begin. Engineers will use and do whatever it takes to produce the end result desired in order to come up with new products and processes.

Duties and Responsibilities of a Mechatronic Engineer

A mechatronic engineer designs mechanical devices that incorporate electrical, software and mechanical components. The combination of these three key areas has resulted in the development and design of mechatronic or smart products. Examples include a more efficient washing machine, automated robotic assembly lines, cameras, laser printers, photocopiers, stair-climbing wheelchairs, hybrid autos and garage door openers. Perhaps the most striking example of mechatronics is the development of the Mars rover used by NASA to take samples and photographs of the Martian surface. Machine intelligence, or AI, is a key component of mechatronic engineer's design plans. An engineer of this type will manage, maintain, develop and design high tech engineering systems that can automate industrial tasks. They design and help in the production of video recorders, cameras and other consumer products. They apply the principles of mechatronic to tasks that may endanger human lives. A mechatronic engineer needs to possess good communication, problem solving and creative skills. They should like engineering and technical activities as well as having an interest in math, physics and mechanical equipment. Employment Outlook Mechatronic engineering is a relatively new area of engineering and graduates of a mechatronic engineering program can work in many industries, including automobiles, manufacturing, gas and oil, mining, transport, defense, robotics, aerospace and aviation. In addition, they have a wide variety of multi-disciplinary skills that will allow them to take traditional engineering positions.

References

[1] Bishop, R. H. (2007). The Mechatronics Handbook, CRC Press, Boca Raton, USA, ISBN-10: 978-0-8493- 9257-3
[2] Brusa, E. (2015). Mechatronics: Principles, Technologies and Applications, Nova Science Publishers Inc, New York, USA, ISBN-10: 978-1-6348-2801-7.
[3] Alciatore, D. G. (2007). Introduction to mechatronics and measurement systems. McGraw-Hill Education. ISBN: 978-0-070-64814-2.
[4] Carryer, J. E., Ohline, R. M., & Kenny, T. W. (2011). Introduction to mechatronic design.
[5]. Kuo, C.-H.; Lin, P.-C.; Essomba, T.; Chen, G.-C. (Eds.) Robotics and Mechatronics. In Proceedings of the 6th IFToMM International Symposium on Robotics and Mechatronics (ISRM 2019), Taipei, Taiwan, 28–30 October 2019; Mechanism and Machine Science Book Series; Springer: Berlin/Heidelberg, Germany, 2020; Volume 78.
[6]. Corves, B.; Wenger, P.; Hüsing, M. (Eds.) Proceedings of the 7th European Conference on Mechanism Science (EuCoMeS 2018), Aachen, Germany, 4–6 September 2018; Mechanisms and Machine Science Book Series. Springer: Berlin/Heidelberg, Germany, 2019; Volume 59.
[7]. Carbone, G.; Ceccarelli, M.; Pisla, D. (Eds.) New Trends in Medical and Service Robotics: Advances in Theory and Practice; Mechanisms and Machine Science Book Series; Springer: Berlin/Heidelberg, Germany, 2018; Volume 65.
[8]. Gasparetto, A.; Ceccarelli, M. (Eds.) Mechanism Design for Robotics. In Proceedings of the 4th IFToMM Symposium on Mechanism Design for Robotics, Udine, Italy, 11–13 September 2018; Mechanisms and Machine Science Book Series; Springer: Berlin/Heidelberg, Germany, 2019; Volume 66.
[9]. Uhl, T. (Ed.) Advances in Mechanism and Machine Science. In Proceedings of the 15th IFToMM World Congress on Mechanism and Machine Science, Krakow, Poland, 30 June–4 July 2019; Mechanisms and Machine Science Book Series; Springer: Berlin/Heidelberg, Germany, 2019; Volume 73.
[10]. Carbone, G.; Gasparetto, A. (Eds.) Advances in Italian Mechanism Science. In Proceedings of the Second International Conference of IFToMM, Cassino, Italy, 29–30 November 2018; Mechanisms and Machine Science Book Series; Springer: Berlin/Heidelberg, Germany, 2019; Volume 68.
[11]. Zeghloul, S.; Laribi, M.A.; Sandoval Arevalo, J.S. (Eds.) Advances in Service and Industrial Robotics. In Proceedings of the 29th Conference on Robotics in Alpe-Adria-Danube Region (RAAD 2020), Futuroscope-Poitiers, France, 2020; Mechanisms and Machine Science Book Series; Springer: Berlin/Heidelberg, Germany, 2020; Volume 84.