AC 2011-2042: MECHATRONICS FOR NON-ELECTRICAL ENGINEERS

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Mechatronics for Non-Electrical Engineers

Abstract

Mechatronics, or Systems Control, is a very valuable topic for students planning on proceeding into manufacturing, processing, or machine design. The use of mechatronics in industry involves the combination of mechanical, pneumatic, hydraulic, and electrical devices working together to control a system, i.e. automation. Although some educational institutions do offer mechatronics as part of the curriculum, most often it is a course for electrical engineering majors. Since the use of automation involves other devices than electrical components, we developed a course for the Mechanical Engineering Technology (MET) students. These students have previous courses in machine design, production design, fluids (Pneumatics/hydraulics), and basic electrical circuits. This paper discusses the issues and methods of creating the course for non-electrical engineering students, having limited or basic electrical knowledge, which would be beneficial for both students and industry.

Introduction

Mechatronics is the combination of different engineering fields to design comprehensive automation systems. The primary fields involved are Control Systems, Electronics, Electrical, Computing, and Mechanical. The Control System portion typically utilizes on of the many Programmable Logic Computers (PLC) as the mediator, or translator between electrical and mechanical components in the system. Electrical Engineering is a key discipline since there are a vast variety of electrical components from simple relays to complex color sensors available in designing a unique systems. In addition, there are the multitude of power sources available (24VDC, 120VAC, 240VAC, etc) that would be part of any design. The Mechanical Engineering discipline has the knowledge of selecting and/or designing motors, pneumatics systems, hydraulics systems, hardware, etc. The Computer Engineering disciplines are key in the storage, retrieval, and analysis of the information produced as an output of the system.

Add Mechatronics Venn Diagram

There are applications for mechatronics the far exceed a short list. The primary users of a designed mechatronics system are automotive, aerospace, medical, defense systems, consumer products, manufacturing, and materials processing.

Course development

We rely on input from our local industries, through an industrial advisory board, to indicate needed course that would allow our students to be of greater value to an employer. Our advisory board, which meets once per year, indicated that a mechatronics or systems control course for our MET students would be instrumental in their attempts to apply automation to currently industrial processes. In addition, our school is ABET accredited and this course would

be an asset in fulfilling some of the requirements[1]. As a result of the board's recommendations and ABET, we created a course with the intent to teach the students how to design an automation system using the concepts and methods of mechatronics. This course is available to the students as a department elective and requires the completion of electrical circuits, fluids mechanics, production design, and machine design. The course is designed to utilize the information learned from these previous courses and design mechatronics systems. Of the four primary engineering fields listed above (control systems, electrical, computing, mechanical), our students lack the in depth knowledge of PLCs that an electrical or electronics engineer would have obtained.

The course was developed with both a lecture portion and a lab portion. The lecture meets twice a week for 50 minutes each and the lab portion is once a week for 1 hr and 50 min. The lecture topics include discussions on the following:

- Automation
- Safety and Error Proofing
- PLCs
- Input devices (electrical and mechanical)
- Output devices (electrical and mechanical)
- Numbering systems
- Boolean math
- I/O modules for PLCs
- Ladder logic diagrams
- Timers
- Counters
- PID
- Control system combinations
    - Electrical-Pneumatic
    - Electrical-Hydraulic
    - Electrical-Motors
    - Electrical-pneumatic-hydraulic-motors

A lab portion for this course would normally be a hands-on electrical lab with programming PLCs and systems of various types. Since our students do not have the extensive electrical background and would have difficulty with some of the electrical lab systems, we opted to use a software simulation package. Our choice for the package was *"Automation Studio"*, which is a commercial/educational package[2]. The software package is very versatile and includes pneumatics components, hydraulics components, electrical components, human-machine interface components, ladder logic, PLC I/O modules, and a vast array of miscellaneous hardware suitable for a mechatronics system. Each component can be customized as needed for the application. The result is that there are thousands of components available. The students are able to combine the components to form simple and complex systems and test the system virtually. When the students have completed the virtual system, the software will simulate the system and show if the components are properly connected and all of the "wiring" is correct. The use of human-machine interface (HMI) components such as lights, buttons, switches, buzzers, etc allow the student to actually see or hear that they were successful in the design of their system.

The students are started with simple systems consisting of pneumatics, hydraulics and simple pumps that they would have learned from previous courses. This introduces the students to the software arrangement, which is new, but using component symbols that the students are familiar with. The second stage of the labs is to start adding simple wiring circuits to the pneumatic/hydraulic systems such as on/off switches and relays. By adding HMI components during the third session, the students are able to interact with the program and start customizing it. As the lab progress, the systems get more and more complex and intricate. The lab topics then turn to PLCs and ladder logic diagrams. The electrical circuit previously used is now converted to ladder logic by the students and PLC input/output modules are used as the connection between the input devices and the output devices. By progressively changing the design system, the students are able to comprehend the changes and improvements throughout the labs. Towards the end of the labs, the topics are on complex mechatronics systems that are both functional and safe. These final programs could easily be converted to actual ladder logic diagrams and each virtual component substituted with real electrical, mechanical components to create an actual working system.

Conclusion

Each year the course is improved and enhanced to offer the students more pertinent information to make them more valuable to an employer. Since this is a draft, there will definitely be additional verbiage throughout the entire paper: but I only have 10 minutes left to submit this!

Bibliography

1. "Criteria for Accrediting Engineering Technology Programs," ABET Technology Accreditation Commission, ABET, October, 2010.
2. "Automation Studio", http://www.automationstudio.com