Concept and Implementation of the Next Generation Mechatronics Courseware for Training and Education

Hector Gamero[1], Shunzhou Yu[1], and Kazuo Yamazaki[1]

hegamero@ucdavis.edu , shzyu@ucdavis.edu , kyamazaki@ucdavis.edu

[1]IMS-Mechatronics Laboratory, Department of Mechanical and Aerospace Engineering, University of California, Davis

Introduction

Mechatronics education was proposed in many universities to teach and train mechanical engineering students or mechanical engineers to enhance their skills and learn how to improve the values of mechanical products and systems in industry. An efficient method for implementing mechatronics education courses is a structure consisting of a lecture portion and hands-on laboratories portion, hence courseware is necessary for building hands-on laboratories. Currently, however, there have been many disadvantages in creating and using this courseware by the use of off-the-shelf components. Therefore, a courseware using Field Programmable Gate Array (FPGA) technology for mechatronics control education and training is presented, and the basic structure of this courseware using FPGA is described. The hardware and software of a detail courseware named MORPH (Mechatronics, On-Chip, Reconfigurable, Programmable and Habitual) has been developed and implemented. This courseware can be used for mechanical engineers in industries and academic researchers as well as students from mechanical engineering.

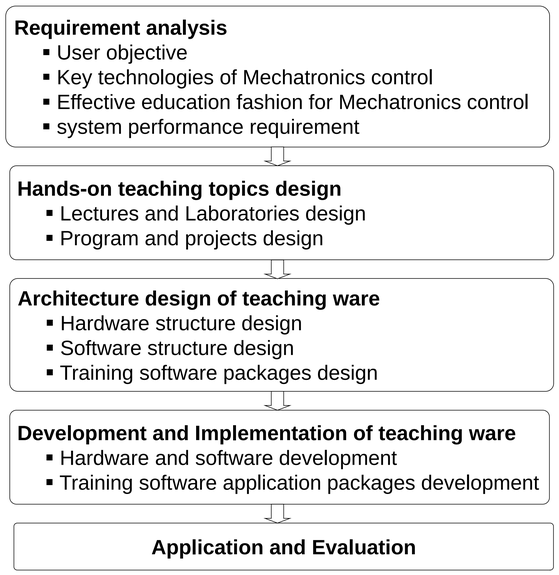
Objective

- Study on conceptual and fashion teaching method for the mechatronics education.
- Develop and enhance a standardized concept of software definable hardware methodology for advanced mechatronics academic training system for the mechanical engineering students.
- Launch a hands-on courseware aimed towards a new methodology for mechatronics education and training system with FPGA technology.

Approach

In this study, the main strategy followed to create a hands-on courseware system is shown in the implementation approach below. Along with these conceptual methods, a set of requirements for courseware were also specified as follows:

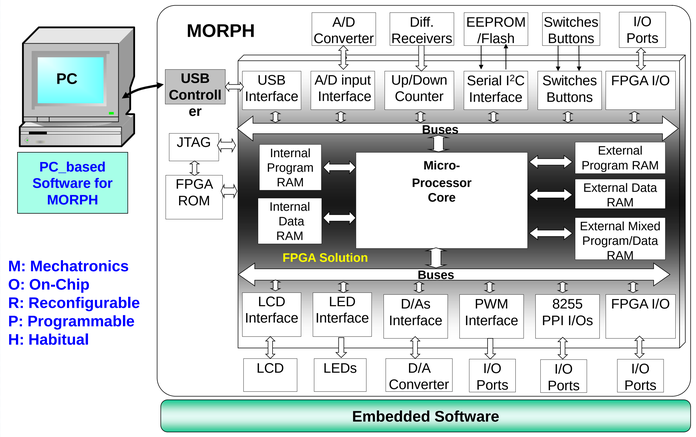
1) Hardware components should be reliable, and the control hardware board should occupy minimal footprint surface area.
2) The compact hardware should be provided in the form of 'assemble kit' which can be easily understood by the student/user.
3) All the hardware components are selected as general as possible.
4) The hardware must be flexible, have scalability and should catch up with the evolution of electronics as much as possible.
5) Software such as languages development associated and a series of application software packages are necessary to let students enhance their design and development skills of hardware and software.
6) Introduction to simple programming languages, such as the BASIC language, can initiate their learning to understand the general contents of mechatronics control.
7) A set of modular control software for education should be prepared so that a student can learn and understand basic operation of the mechatronics control system.
8) All software tools should be included as much as possible inside the courseware.



Implementation Approach

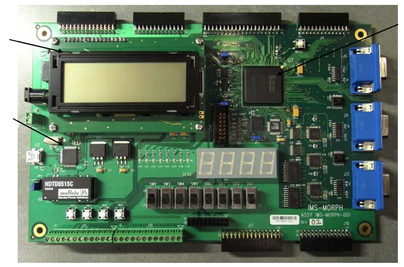
Results – Hardware

Functional Description of MORPH System

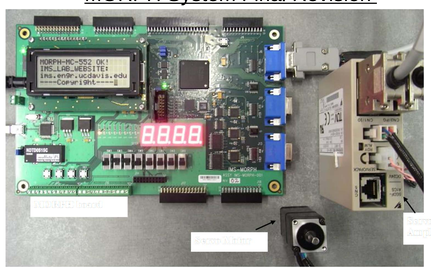


M: Mechatronics
O: On-Chip
R: Reconfigurable
P: Programmable
H: Habitual

MORPH System



MORPH System Final Revision

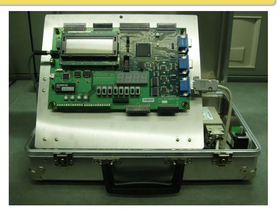


MORPH System with Servo Amplifier and Servo System

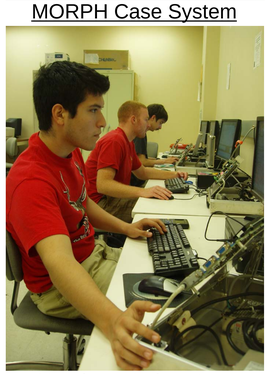
Results – Hands-on Lab

Concepts to be learned
•Concept of microprocessor architecture and its operation.
•Application interfacing technology for mechatronics system control.
•Concept of software development technology.
•Concept of control technology for mechatronics system.

One Axis Position Control in Lab
•Understand the basic concepts of one axis position control
•Understand the frame structure of free time system (FTS) and real time system (RTS) which is usually adopted as the software structure for mechatronics system control
•Learn how to organize the free time system and timer interrupt program as real time system, organize the simultaneous execution of FTS and RTS
•Understand how to write and execute the written program using MORPH system.



MORPH Case System



Hands-on Laboratory

Conclusions

- For efficient mechatronics education, the teaching style of lecture mixed with hands-on project is necessary.
- Courseware for this type of education should consist of the general hardware configuration of a mechatronics control system and necessary software to enhance to teach the concepts of mechatronics control and latest technology.
- The developed MORPH system consists of compact mechatronics control hardware and structured training software.
- In the future, more and more software definable hardware modules will be developed and configured into FPGA, so this courseware is always updated with the state-of-the-art technology, and also more and more training software packages will be added into MORPH training software such as C language development package so that student can learn more applicable and latest technologies and skills.