Introducing Students to the Concept of Embedded Systems

James M. Conrad

jmconrad@uncc.edu, Electrical and Computer Engineering, UNC-Charlotte
9201 University City Boulevard, Charlotte, NC 28223, 704-687-2535

Experts say that embedded systems are "everywhere" around us. Embedded systems is the field of putting “computers” (namely microprocessors and microcontrollers) into everyday items, like microwave ovens, cell phones, and automobiles. These computers typically perform limited, simple functions. Although the field has been active for decades, it is only now being identified in Computer Science and Computer Engineering curricula. Few colleges and universities offer such a course, and few textbooks exist to use in a course.

Faculty at North Carolina State University and UNC Charlotte have created and refined an introductory course to teach students the concepts of embedded systems. This Junior/Senior-level class is an introduction to designing microcontroller-based embedded computer systems using assembly and C programs. The goal of this course is to solidify and build upon a student’s knowledge of computer organization by presenting hands-on hardware/software co-design experiences with microcontrollers. This includes controlling LEDs and LCDs, reading push buttons and potentiometers, developing communication protocols, and creating real-time operating components. Students also examine a few sensors that are used in commercial products and learn how to interface them in a microcontroller system. Students learn to recognize and identify the constraints facing embedded system designers, and determine how to assess them.

This paper describes this course, including topics covered and the scope of laboratory assignments. Of particular interest is the assessment of the student’s ability to co-design hardware and software solutions, when historically they only addressed one of these areas in courses. A comparison of student success is analyzed. Over the course of three semesters in 2003, the author taught this class to 310 undergraduate students at these two universities. The author was able to correlate success in the course based on prerequisite knowledge. This paper also assesses the value of requiring students to purchase their own embedded systems development kit used in the class.