Harnessing the Power of Arduino for the Advanced Lab

Indiana University Purdue University-Fort Wayne
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(Six Setups)

Host and Mentor

Herbert Jaeger is Professor and Chair of the Department of Physics at Miami University. He obtained an Electrical Engineering degree from the University of Applied Sciences in Darmstadt, Germany (1977), and and M.S. (1984) and Ph. D. (1987) in Physics from Oregon State University. He has been involved in both of the electronics courses off and on since joining Miami University in 1992. A couple of years ago he started to implement a number of Arduino experiments in the sophomore Electronic Instrumentation Lab and recently has begun to replace some of the advanced lab experiments with Arduino-controlled versions.

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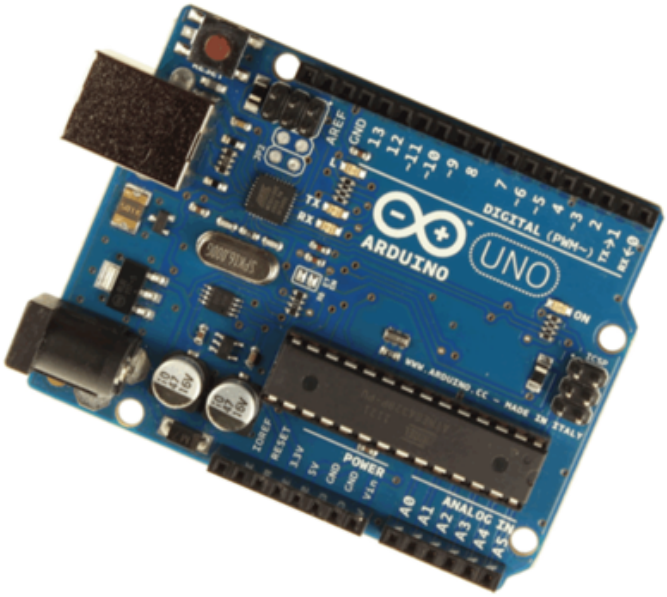
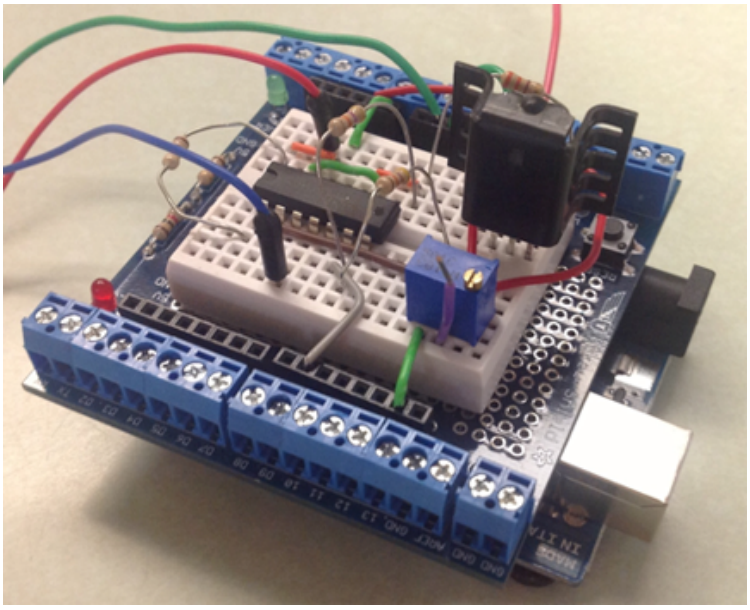
Microcontrollers are increasingly taking over control and data acquisition in the laboratory. Often they are embedded in an instrument to control its function. Stand-alone low-cost

microcontrollers became available over the past decade and have been in use by hobbyists and artists, and have also found their way into the laboratory.



In this Immersion workshop we will be focusing on the Arduino, one of many microcontroller boards on the market; its mark of distinction is an open-source architecture with support under Windows, MacOS, and Linux platforms. Arduinos come in many shapes and forms, including wearable varieties that can be sewn into clothing and connected to sensors and actuators with conductive thread. We have utilized the Arduino extensively in our sophomore electronics lab and are beginning to use it in our advanced labs as well. The goal of this Immersion is to introduce participants to the Arduino platform and get them familiarized with programming and interfacing these microcontrollers, so that participants will be able to use Arduinos with their own projects at their home institution.

Arduinos typically have digital I/O lines, counters and timers, as well as analog inputs with 10-12 bit resolution. They are easy to program and readily integrated with laboratory instrumentation and circuitry to help control experiments and automate measurements. Participants will learn to program the Arduino and have it communicate with a host computer and with an LCD display; the use of digital I/O lines to read the status of switches and control actuators; analog-to-digital conversion via built in analog inputs or external A/D converter; the use of pulse-width-modulation to deliver analog power by digital means; to transmit of digital data via shift registers; the use of a digital potentiometer.



Day one of the Immersion will be dedicated to learning Arduino basics: the Arduino programming language, and the use of the integrated development environment to write programs and upload them to the Arduino, as well as using the serial monitor to communicate with a host computer. We will explore working with digital I/O lines to control external circuitry, and to read the status of switches or push buttons. Next we will learn to use the analog input lines that provide built-in 10-bit (Arduino UNO) or 12-bit (Arduino DUE) A/D conversion capabilities. If higher resolutions are required and external A/D converter must be used, and we will show how that is done with the Arduino.

On the second day we will examine a variety of sensors to measure temperature, pressure, light intensity, sound, and other quantities. We will explore the use of stepper motors and servos to make things move. The remaining period of day two and day three will be used to work on projects, such as an autonomous Arduino robot, a temperature-controlled characterization of a pn-junction, or the measurement of thermal conductivity and the specific heat.

All workshop materials will be supplied, however, if you wish you can bring your own laptop and Arduino to use during the workshop. For a shopping list, see the separate document "Arduino Setup Cost."

Financial support to help purchase apparatus used in Laboratory Immersions is provided on a competitive basis by a program of the Jonathan F. Reichert Foundation. Limitations and exclusions apply, but generally speaking the foundation may support up to 40% of the cost of the required equipment. Arduinos are specifically excluded; however, apparatus that is controlled by the Arduinos might be supported.
