Using the Ardunio in Freshmen Design

MARK E. CAMBRON
Department of Engineering
Western Kentucky University
Bowling Green, KY 42101
mark.cambron@wku.edu

***Abstract*— This paper will present the implementation and usage of the Arduino Uno microcontroller into EE Design I. EE Design I introduces design and electrical engineering to freshmen students. The Arduino Uno is a single-board microcontroller designed around the 8-bit Atmel AVR microcontroller. The board has a simple development environment that runs on both PCs and Macs and allows users to write programs using C and C++. The Arduino Uno is a low cost platform that can be bought for roughly $30. The low-cost easy to use board is an ideal platform to introduce programming and design to freshmen engineering students. Projects in this course support our vision of project-based engineering. In this paper will discuss the robot project and the experiences developed to prepare students for their project**.

Keywords—Arduino, Project Based Engineering

INTRODUCTION

Western Kentucky University's (WKU) electrical engineering program believes it crucial for students to experience engineering during their freshmen year. Throughout the electrical engineering curriculum hands-on experiences have been incorporated. WKU EE program believes in project based learning [1-3]. Faculty are expected to engage students in activities to support and nurture a clear understanding of engineering practice.

EE Design I is a one-credit hour course offered in the spring semester of the freshmen year to electrical engineering students at WKU. The goal of this course is to introduce the field of electrical engineering using simple projects, electronics and programming. During this design experience the students solder components, fabricate a frame, and program a robot to navigate a simple course autonomously. Students are given safety training and are introduced to fabrication and the prototype facilities. The Arduino Uno is a single-board microcontroller designed around the 8-bit Atmel AVR microcontroller. The Arduino Uno is a low cost and easy to use development tool. Students control their robot with the Arduino Uno.

PROGRAMMING WITH ARDUNIO UNO

A small course fee allows each student to be given their own Arduino Uno. The Arduino Uno is a single-board microcontroller designed around the 8-bit Atmel AVR microcontroller introduced in 2005. The board has a simple development environment that runs on both PCs and Macs and allows users to write programs using C and C++. The Arduino Uno is a low cost platform that can be bought for roughly $30.

The Arduino Uno is an ideal platform for electrical engineering students to be introduced to programing [4-7]. The software development environment can be downloaded from the Arduino website at no cost. The development platform, shown in Figure 1, has reference information that details the available commands and many of the libraries. The development environment has many examples on how to use the libraries and functions.

Figure 1
Software Development Environment

In order for students to become familiar with the Arduino environment several programming projects were developed. Students were introduced to the reference webpages, getting started videos, help tools and the sample programs supplied with the board. Students were required to write programs using for loops, if statements, and serial communication. The second round of programs introduced students to using libraries and digital inputs and outputs. Students were given servo motors and digital IR line sensors (Figure 2).

Students were asked to become familiar with the resources supplied by Arduino. Before the first lecture on Arduino Uno the students watched tutorial videos developed by hobbyist on YouTube [8-10].

Figure 2
Servo Motor and IR Sensor

After introducing the programming environment and reference material students were given a set of programming assignments. Students were required to write programs using for loops, if statements, and serial communication. These assignments included:

- Classic Hello World program helps insure that the software is installed correctly and introduces students to serial communications.
- Students are introduced to for loops.
- If statements: Introduce students to "if" statements and comparison operators. This program incorporates parts from the Hello Word and also used for loops.

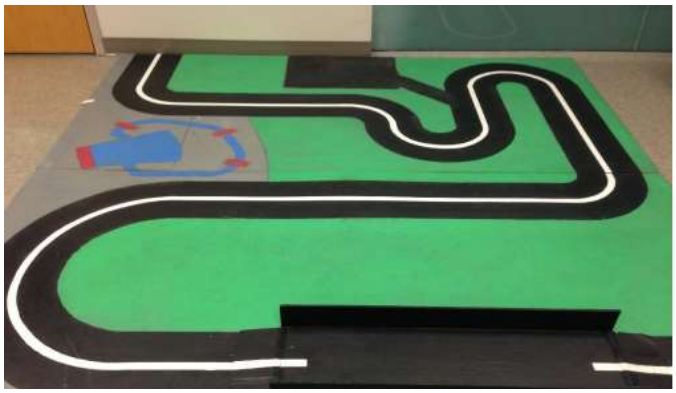

Figure 3
Autonomous Robot Project Course

The second round of programs introduced students to using libraries and digital inputs and outputs. Students were given servo motors and digital IR line sensors.

Servo motors are common in many applications. In this class we used a modified servo motors that allows the shift to turn freely. Arduino has library that allows users to set a speed of rotation for a servo motors. Students are asked to demonstrate the use of both the servo and the IR line detection sensor. Students are then asked to write a program that turns the servo clockwise when the sensor is active and counterclockwise when the IR sensor is inactive.

AUTONOMOUS ROBOT PROJECT

Students were divided in teams of 2 or 3 students to design and build an autonomous robot to complete the course shown in in Figure 3. Table 1 shows a list of parts given to each team. Students are required to fabricate the robots body to carry the microprocessor and mount the sensors. Aluminum, wood, and Lexan are commonly used by teams to construct the robot's frame.

TABLE I
PART LIST FOR EE DESIGN I ROBOT

Part	Number
Arduino Uno	1 PER STUDENT
IR Sensor	2
Modified Servomotors	2
Plastic Wheels	2
Standoffs	2
9 Volt Battery	2
Caster	1
10k Ω resistors	4
1 ft of 18 gauge wire (black)	1
1 ft of 18 gauge wire (red)	1

The course has several challenges that students must overcome. The majority of the course is composed of a series of turns with a white line. This obstacle can be overcome using 2 digital IR sensors that can determine if it is over black or white. Students program their robot to go forward or turn left or turn right to keep the robot centered on the white line. Another obstacle is a short bridge that has a small incline and area with walls but no white line. Most students are able to overcome this obstacle by modifying their robot to run along the wall and going straight. Figure 4 shows and example of modifications that allows the robot to move along the wall.

Figure 4
Robot

CONCLUSIONS

The Arduino Uno was first introduced to the EE 101 in the spring 2013. In two offerings 46 students have design,

built and successful completed the autonomous robot project using the Arduino Uno. Students have been very enthusiastic about the project. They were surveyed at the end of the project and expressed that overall this was a very positive experience

The autonomous robot project forms a foundation for the students in skills such as circuit construction and elementary programming. Also, the students were introduced to reading a schematic. This project provided a hands-on opportunity for the students to learn about the field of electrical engineering. The robot was their first experience working with electronics and processors. This type of opportunity is invaluable for retention purposes and for aiding students who are unsure about the major. Students were allowed to keep the Arduino Uno and can use it in other projects.

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