

Intelligent Systems Design in a Non Engineering Curriculum

Embedded Systems Without Major Hardware Engineering

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Overview

- **Motivation**
 - Real time systems
 - non PC software development
- **New Course**
 - **Goals:**
 - Small scale microcontroller system development
 - Focus = hardware control and interaction
 - Advanced computer science students (graduate / undergrad)
 - Limit need for hardware development (and cost)
- **Results – Fun, successful course**
 - Limited hardware knowledge not a barrier
 - Changed student perceptions
 - **Economical**



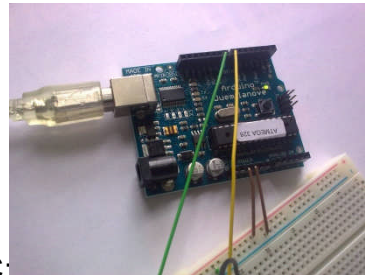
Course Tools



- Hardware

- Arduino open source microcontroller board

- Atmel Atmega 328 processor
- 32K bytes of memory
- Power options, clock, timers
- inputs / outputs
- Physical reset button



- Wireless breadboards

- Electronics parts

- Software -Programming in C:

- Standard C, interfaces to hardware, helper methods
- Boot loader, USB interface
- Very basic main loop “operating system”

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Software Structure



```
/*Blink
```

```
Turns on an LED on for one second, then off for one second, repeatedly.
```

```
The circuit: LED connected from digital pin 13 to ground.
```

```
By David Cuartielles; based on an original by H. Barragan for the Wiring i/o board
```

```
*/
```

```
int ledPin = 13; // LED connected to digital pin 13
```

```
// The setup() method runs once, when the sketch starts
```

```
void setup() {
```

```
  // initialize the digital pin as an output:
```

```
  pinMode(ledPin, OUTPUT);
```

```
}
```

```
// the loop() method runs over and over again, as long as the Arduino has power
```

```
void loop()
```

```
{
```

```
  digitalWrite(ledPin, HIGH); // set the LED on
```

```
  delay(1000); // wait for a second
```

```
  digitalWrite(ledPin, LOW); // set the LED off
```

```
  delay(1000); // wait for a second
```

```
}
```

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Hardware Tinkering



- Project Construction
 - Arduino board a piece part
 - Add
 - Inputs – buttons, sensors (temp, sound, touch)
 - Outputs – LEDs, motors / servos, speakers
 - Need to learn basic electronics
 - What's a multi meter?
 - Electrostatic Discharge (ESD) precautions
 - Only 9 volts and milliamps, but...



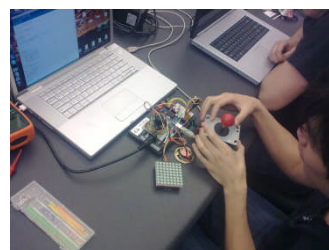
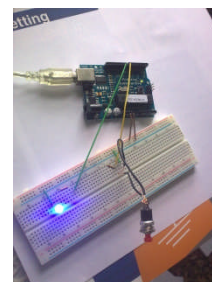
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Course Structure

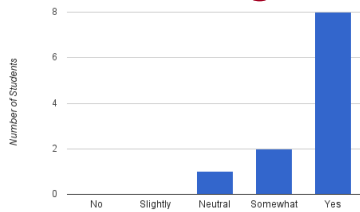


- Introduction to Arduino and Hardware
 - Series of simple projects
 - Experimentation with sensors
 - Build simple circuits from diagrams
 - Access to the Arduino community
- Custom Project(s)
 - One or two people
 - Student defined project
 - In class demonstrations and help
 - Student self assessment of others



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Findings & Results

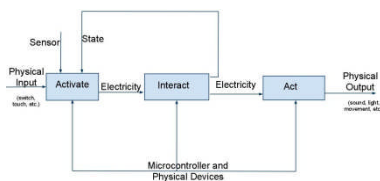


Reasonable Economics (USD):

- \$150 per student kit
- \$500 in hand tools
- \$45 damaged parts

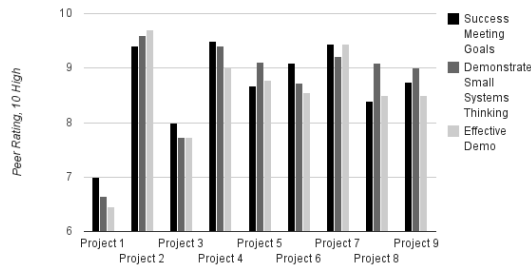


Do you understand the difference between programming microcontrollers and higher level programming(i.e., Java)?



Structured Analysis and Design Technique (SADT)

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Advanced Projects



Arduino: capable platform; enables creativity



Arduino Glider Auto Pilot

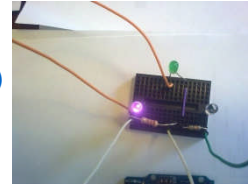
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Next Steps / Improvements



- Speed up the basics
 - Expanded standard set of labs
 - Circuit experiments (no Arduino)
- Option to BYO Arduino
 - Build Arduino from parts
 - Students enjoyed soldering
- Option for assembly code
 - When is timing really critical?
- Expand in robotics
 - Interest is keen
 - Real time input and response



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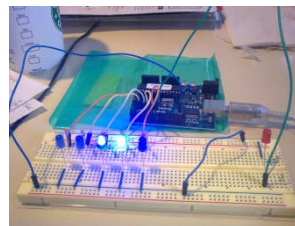
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Summary



- Small scale intelligent systems / embedded computing
 - Important student learning
- Arduino open source hardware / software
 - Accessible for advanced computer science students
 - Even those without electronics background
 - Strong and capable platform
- Economics – possible for non engineering schools
- Acknowledge
 - Reviewers, Thanks!
 - Arduino Community:
 - Massimo Banzi, Tom Igoe, ...



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Backup Materials



- Rover Videos:
- see <http://technospino.com/micro/>

- Robert's YouTube:
- <http://www.youtube.com/watch?v=moFl8xIHG9c>

