Gateway To Space

ASEN 1400 / ASTR 2500

Class #9

Colorado Space Grant Consortium
Today:

- Announcements

- Next Time

- One Minute Report Questions

- Arduino Part 1: Type and Blink
## Announcements:

- More Syllabus changes…

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<td>09-25-12</td>
<td>HANDS-ON: Arduino – Part I (Type and Blink) &gt; Multiple, Button, Fade, and Potentiometers</td>
<td>HW 04 DUE HW 05 Assigned</td>
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<td>09-27-12</td>
<td>In-Class - Team Proposal Time</td>
<td>HW 06 Assigned</td>
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<td>09-28-12</td>
<td>PROPOSALS DUE 4:00 PM</td>
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<td>10-02-12</td>
<td>REVIEWS: Conceptual Design Review (CoDR)</td>
<td>Presentations DUE 7:00 AM DD Rev A/B Assigned</td>
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<tr>
<td>10-04-12</td>
<td>HANDS-ON: Arduino – Part II (Sensors) &gt; Temperature, Pressure, Accelerometers, and Shields</td>
<td>HW 05 DUE Passwords today</td>
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<td>10-05-12</td>
<td>&gt;&gt;&gt; Authority To Proceed (ATP) by appointment with Chris &lt;&lt;&lt;</td>
<td>9 AM – 3 PM + HW 06 DUE</td>
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<td>10-09-12</td>
<td>HANDS-ON: Arduino – Part III (Memory) &gt; SD Cards and Samples</td>
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Announcements:

- CoDR Template is on the Website – DUE 7 AM 10-02-12

- New HW #5 on Website – DUE in class 10-04-12
Announcements:
Announcements:
Announcements:

- Class email list, who is still not getting emails?

Gateway To Space

Here is how to subscribe to the class email list...

Please enter your email in the box below and select "Subscribe". It is just that easy. I will use this list for all class communications. You will need to know the password given in class on August 28, 2012.
Announcements:

Additional Class Directions…

1. All Team meetings shall be held on campus.

2. No team meeting or team function associated with this class shall involve alcohol, whether student(s) is/are of legal age or not.

Any team and/or team member that does not follow these clear directions going forward will result in academic and/or disciplinary action in this class, in said student's department, as well as in the College of Engineering and Applied Science.
Next Time...

In-Class Team Time

Proposals Due 9/27 @ 4PM

How is it going?

Colorado Space Grant Consortium
That’s Me!
National Aeronautics and Space Administration

Group Achievement Award

University Suborbital Launches RockOn! and HABP

For exceptional achievement in implementing suborbital student flight opportunities to recruit the next generation of scientists and engineers.

Signed and sealed at Washington, DC
The second day of August
Two Thousand Twelve

Administrator, NASA
Roll the Movie...
Arduino Part 1:
Type and Blink
**Arduino Overview:**

- Last class, solder and blink

But…
- How do you change it?
- How can you really use this?
- What could you use?
Arduino Overview:
Arduino Overview:
Arduino Overview:

“Designing a revolutionary concept in software demanded a computer with extraordinary performance. The Tandy 2000 delivered.”

Bill Gates
Chairman of the Board, Microsoft

Bill Gates has been at the leading edge of personal computing from the very beginning. His company is a leading producer of microcomputer software.

“Our newest software product, MS/Windows, is an integrated environment. It will let personal computer users combine individual programs into powerful, integrated systems.

“When we set out to design MS/Windows in color, we knew that the Tandy 2000 computer would let us turn an extraordinary product into a work of art. The graphics are sharp and crisp, and gave us a degree of creativity like nothing before.

“Our engineers were quite impressed with the processing speed of the Tandy 2000’s 8088 microprocessor, too. And while the finished product will utilize the 8088’s Digi-Mouse, the well laid out keyboard has helped us speed through the design stage.

“We’re proud of our work. So when we want to show someone how great MS/Windows really is, we give them a demonstration. On the Tandy 2000.”

Isn’t it time you enjoyed peak performance from a personal computer? Go ahead, watch how much faster today’s most sophisticated programs run on the high technology Tandy 2000.

You can choose from the hottest programs around, too, with our exclusive Express Order Software service.

Tandy 2000 systems start at $2999, and can be leased for only $299 per month*. Come in today and see what you’ve been missing.

Our new 1986 computer catalog is yours for the asking at any Radio Shack Computer Center or participating Radio Shack store or dealer. Check out our complete line of microcomputers—in pocket models to laptop portables, from powerful desktop computers to multi user office systems. We have it all. That’s why we invite comparison!
Arduino Overview:

**General Purpose computer**
- Usually has a human in the loop
- Can be reconfigured to do any number of tasks (excel, email, music)

**Embedded Systems**
- Human input not required all the time
  - Takes specific inputs and computes outputs for a very specific application
- Meets real-time goals
  - Heart monitor
  - Automatic braking systems (ABS)
CoDR Template is on the Website – DUE 7 AM 10-02-12

New HW #5 on Website – DUE in class 10-04-12

Announcements:
CoDR Template is on the Website – DUE 7 AM 10-02-12

New HW #5 on Website – DUE in class 10-04-12

Announcements:
Arduino Overview:

Bit nervous how this might go…
Arduino Overview:

What’s under the hood?

- **USB**
- **9V DC Power In**
- **5.0 V Regulator**
- **3.3 V**
- **5.0 V**
- **GND**
- **6 Analog Inputs**
- **14 Digital Input/Outputs**
- **External Interrupts**
- **Serial I/O**
- **ATmega328**
  - 10 Bit ADC
  - 16 MHz
  - 32 KB Flash
  - I2C & SPI
  - 40 to +85C
Arduino Overview:

Arduino (TM) UNO Rev3
Arduino Overview:

- So what does all that mean?
Arduino Overview:

The Easy Stuff…

USB

5.0 V Regulator

9V DC Power In

3.3 V

5.0 V

GND
Arduino Overview:

The Chip...

ATmega328
- 10 Bit ADC
- 16 MHz
- 32 KB Flash
- I2C & SPI
- 40 to +85C
Arduino Overview:

Arduino (TM) UNO Rev3
Arduino Overview:

Other…

- 14 Digital Input/Outputs
- 6 Analog Inputs
- Serial I/O
- External Interrupts
Arduino Overview:

Arduino (TM) UNO Rev3
Analog vs. Digital
Analog:
- Voltage, continuous, real-world
Digital:

- Bits and Bytes, On/Off, 1 or 0, high or low, non-continuous
**Digital:**

- A state is one unique combination of bits
  - 1 bit – 0 or 1 = 2 states = $2^1$
  - 2 bits – 00, 01, 10, 11 = 4 states = $2^2$
  - 4 bits – 0000, 0001….1111 = 16 States = $2^4$
  - 8 bits = 00000000….11111111 = 256 states = $2^8$
  - 16 bits = 0000000000000000…1111111111111111
    = 65,536 states = $2^{16}$

- More bits provides more precision over a given voltage range

- If it is necessary to record small changes, more precision (bits), is required

- 8 bits is a byte

- 10 bits is how many bytes?
Digital:
- Bits and Bytes, On/Off, 1 or 0, high or low, non-continuous

Red line – 2 bits = less info
Green line – 4 bits = more info
Analog vs. Digital

- What is the difference between 8-bit and 10-bit conversions?

  - An 8-bit conversion has $2^8$ (0 to 255) possible values,

  - Resolution is $1/(2^8 - 1) \times 5V = 1/255 \times 5V = 0.0196$ V
Analog vs. Digital

- A 10-bit conversion has $2^{10}$ (0 to 1024) possible values

  - Resolution is $\frac{1}{(2^{10} - 1)} \times 5V = \frac{1}{1023} \times 5V = 0.00489$ V

- For a device that is very precise, a 10-bit conversion allows for a higher resolution on the data (high-range accelerometers)
Analog vs. Digital

42.0°C temp
Real World

Real World to
Analog Voltage

0°C = 0V
50°C = 5V

3 = 11 binary

(4.20V / 5.0V * 4)
= 3.36
= 3

Storage for
later use

4.20V = 42.0°C

2 bit ADC

5V = 3

0V = 0

ADC = Analog to Digital Converter
= Voltage to Binary
Sensor & Storage

42.0 C temp
Real World  

Real World to
Analog Voltage

0C = 0V  50C = 5V

860 = 1101011100 binary

4.20V = 42.0 C

10 bit ADC

5V = 1023

0V = 0

Storage for later use

ADC = Analog to Digital Converter
= Voltage to Binary
Let’s take it for a drive…

Arduino Overview:

- **USB**
- **5 V Regulator**
- **9V DC Power In**
- **3.3 V**
- **5.0 V GND**
- **6 Analog Inputs**
- **14 Digital Input/Outputs**
- **Serial I/O**
- **External Interrupts**
- **ATmega328**
  - 10 Bit ADC
  - 16 MHz
  - 32 KB Flash
  - I2C & SPI
  - 40 to +85C
Arduino Overview:

- Launch the Arduino Software 1.0.1
- Sketch
Arduino Overview:

- File/Examples/01.Basics/BareMinimum
Arduino Overview:

Compile

Upload

Serial Monitor

Code

Message Box
Arduino Overview:

```c
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}```
Arduino Overview:

- Connect your Arduino Uno to your laptop via the USB cable

- Select right board = Tools/Board/Arduino Uno
Arduino Overview:

1. Compile code and check for messages

2. Upload code to Arduino (checking communication with board)
Arduino Overview:

- Any problems?

- Everyone, please wait until this has been completed
Arduino Overview:

- Add the following to the sketch…

```cpp
/*
   Blink
   Turns on an LED on for one second, then off for one second, repeatedly.

   This example code is in the public domain.
*/

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;
```
**Arduino Overview:**

- Add the following to the sketch...

```cpp
void setup() {
  // put your setup code here, to run once:
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}
```
**Arduino Overview:**

- Add the following to the sketch...

```cpp
void loop() {
    // put your main code here, to run repeatedly:
    digitalWrite(led, HIGH);  // turn the LED on (HIGH is the voltage level)
    delay(1000);              // wait for a second
    digitalWrite(led, LOW);   // turn the LED off by making the voltage LOW
    delay(1000);              // wait for a second
}
```
Arduino Overview:

1. Compile code and check for messages

2. Upload code to Arduino (checking communication with board)
Arduino Overview:

- Does LED blink?

- Change the delay in the sketch and try again

- Do you see a change?
Arduino Overview:

- If you can Blink an LED, you can do anything

- Why?