Robosail Workshop 2

<u>Objectives</u> Students will:

- Identify parts and functions of an Arduino computer board.
- Investigate data from RC Receiver and wind sensor using Arduinos and test code.
- Learn range of Rudder and Sail servos using Arduinos and test code
- Test the entire RoboSail system using Arduinos and test code.
- Put Arduino and electronics in the RC system to test and investigate complete system.
- Write first Arduino program that takes in data and controls a servo

Materials:

- Wiring diagrams
- Student Worksheet to record ranges of transmitter, sensors, and servos
- Set of wires for each boat: 2 servo "big end" to bare wire, 2 servo "small end" to bare wire, 1 wind connector to bare wire.
- 3 or 4 RC boats
- Up to 4 laptop/Arduino Unos/USB cable for each boat

Part I Arduino Tour (30 min)

1. Arduino parts and functions
    a. Show Arduino tutorial powerpoint (adapted from Sparkfun)
    b. Check out fun Arduino-based projects at
       http://www.instructables.com/id/20-Unbelievable-Arduino-Projects/

2. Continue Arduino tutorial from last workshop
    a. Rename it ServoXX1 (XX is your intitals) and save
        i. Brief discussion of naming conventions (camelCase, versions)
    b. Show features
        i. How different words light up in color
        ii. Verify/compile and upload buttons
        iii. Semicolons
        iv. Curly brackets and parentheses
        v. Font size (preferences)
        vi. Line numbers (preferences)

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Part II Use Arduino to investigate sensors and actuators (120 min)

Summary: Students either work individually or in pairs to investigate system components and their associated code. Each student/pair has an Arduino of their own, several can be used on 1 boat. Go through them in any order. Use Worksheet in student booklet to record progress and notes.

1. Review parts of a boat: mechanical and electronic
   a. Rudder and Sail Servos, connection of mainsheet and jib sheet
   b. RC Receiver – Rudder and Sail channels
   c. Wind sensor, GPS, and compass

2. Investigate the Wind Sensor
   a. Connect Wind Sensor to Arduino board as shown on wiring diagram
   b. Use program WindSensor.ino to verify wind sensor wiring and calibration.
   c. Adjust windvane as needed so that 0 means wind is coming from the bow.
      a. Loosen the nut, rotate the encoder body, tighten nut
      b. Its hard to get closer than 2 or 3 degrees
   d. Check that the values increase in the CCW direction
   e. Check for the maximum raw data coming in from the Wind sensor
      a. should not be greater than 1023 (10 bit digital)
      b. Write on the worksheet
   f. Check that there is not a significant dead spot where the encoder goes back to 0
   g. See the header in WindSensorTest.ino for further information

3. Investigate the RC receiver
   a. Connect the Receiver to Arduino board as shown on wiring diagram
   b. Use program RCReader.ino and verify the connection to receiver.
   c. Record the range of values for Rudder and Sail controls and write on the Worksheet
   d. See the header in RCReader.ino for further information

4. Investigate the Rudder Servo
   a. Connect the Rudder Servo to the Arduino as shown on wiring diagram
   b. Use program RudderServotest.ino
   c. Check that the rudder is centered on 0, if not adjust it mechanically
   e. Find out how many degrees it moves to each side. Write on worksheet
   f. See the header in RudderServotest.ino for further information

5. Investigate the Sail Servo
   a. Connect the Sail Servo to the Arduino as shown on diagram
   b. Use program SailServotest.ino
   c. Check that the sail is full-in (as for close haul) at 0, adjust lines as necessary
   d. Find out how many degrees it moves for full-out. Write on worksheet
   e. See the header in SailServotest.ino for further information

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6. Use program RCPassThrough.ino to check full system wiring
   a. Connect all system electronics to the Arduino as shown on diagram
      i. Try out the system – control the boat as before, but with the RC controls going through computer to the servos.
      ii. Unplug the computer and pug in the 9V battery. Check that it works like the original RC boat (but with computer in between the controls and the servos)
   b. Congratulations - You are ready to write code!

Part III Create Arduino program: RudderFollowsWindvane (30 min)

Summary: Exercise program where students read in data from windvane and use it to create an output command for the rudder. Note: This is not something that would be done in real sailing, but it is a good exercise to build from.

1. Plan and Code a simple task: Rudder follows Windvane
   a. Draw/write an algorithm for having the rudder follow the WindVane. Remember that the Windvane can go all the way from -180 to +180 and the Rudder can only go -60 to +60.
   b. Your algorithm can have the relationship be 1:1 or scaled. Consider using the Arduino "map" command
      i. Option 1: map range of wind sensor to range of rudder
      ii. Option2: 1:1 mapping with constraints at range of rudder
   c. Download BoatCodeStarter and save it as RudderFollowsWind
   d. Code your algorithm and test it in the classroom with someone moving the windvane