# CSE 6324 From control to actuators

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Lecture 2

Tuesday, 13 September, 11

### From the bottom up...

- There are two kinds of motors on our robot
  - DC Servo motor
    - Steering
  - DC motor
    - Drive
  - We need to power both of them
  - · We need to control both of them





# The plan...

- Lectures this week
- No class next week
- Start building the week after

(i) Need to sort into 2-3 groups(ii) Need to get your emails(iii) The 26th -> lab

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### RC Servo motor

- Basically, it is a controllable motor.
- Typically low speed, reasonable torque, ok accuracy



### RC Servo motor

- Externally three wires
- Potentiometer monitors rotational angle of the motor.
  - Some backlash on the gear train
  - Inaccuracies in the potentiometer
  - Typically not capable of continuous rotation.

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### RC servo motor

- Externally the servo motor presents three wires
  - Different standards, ours (probably) uses Japan Radio Standard
- Two wires provide power and ground
- Third provides control



### RC Servo motor

- Basic control mechanism is known as pulse width modulation.
- Basic idea is to send a signal along the signal control and the motor moves to the associated position.
- Electrically this works on a modified version of PWC (pulse width modulation)
  - Send a square wave where the on duty cycle defines the commanded position.

### RC servo motor Arduino

- Fortunately we (probably) don't care.
- Just use a standard library (servo library) on the Arduino



red

positive

orange

signal

brown

negative

One servo (ND: we will wre it d

### RC Servo motor Arduino



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### **RC ESC control**

- Caveat: ESC's are designed to power up safe
  - Need to 'arm' the ESC. Drive it full (180). Wait. Drive to off (0). Then it should operate the way you want
  - 0 off
  - 180 full
- We will need to experiment with this...

# But what about the other motor?

- The drive motor drives continually
  - Not a servo position device like rudder.
- RC electronic speed control (ESC) works by pulsing a motor on/off very quickly (higher duty cycle -> more power).
- From a control point of view looks like an RC servo
  - This means we can control it like a RC servo

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# Wiring

- One last detail...
- We have a BEC (battery eliminator circuit) on the boat.
- 3 channels from the ESC (BEC) include +5 and gnd. So...
  - Wire +5 from BEC to Arduino Vin
  - Wire GND to Arduino GND
  - Then wire the RC servo to +5 and GND, and two signals to digital input-output lines

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# So what else is needed at the bottom end?

- Charger for our batteries (it has not yet arrived, looks like the order got lost).
- Two Japanese wiring harness compatible connectors
- Headers for the Arduino
- Programming for the Arduino..

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### Compass

- Basically two groups of digital compasses
  - Tilt-compensated
  - Non-tilt-compensated
- · Given our application, we want tilt-compensated.
- Many units available...will have one sourced in 2 weeks

# Your task (2 weeks)

- Get an Arduino from me
- Get the software for your machine
  - www.arduino.cc
  - Design software library (tty simulation)
    - Command sequence, prompt (\*, error, etc.)
    - 🔹 l (init)
    - H <heading> (H 0..180)
    - T <throttle> (T 0..180)
    - C <compass> returns string
    - K (kill)

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#### Compass



- Roughly \$130 (each)
- Uses the 'wire' library to talk to the unit (think serial communication)
- Another option is to buy a USB version of this thing..depends on pricing and availability

### So, when this is done ...

- Have a USB device that emulates a serial port
- Send it commands (I, H, T, K) to drive the robot
- Have some way of getting heading (C?)
- Want to provide closed-loop control

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# So lets start simply

- Have a desired heading setpoint  $(\theta)$
- Have a current heading
- Have a current rudder angle
- How do we manipulate the rudder to reduce the error to zero?



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# USV autopilots

- Huge literature on this
  - Will post some examples on the course web page but a quick google will get you many.
- Most are commercial
  - Often integrated with GPS given their application
- Here we are looking at heading based ones