COS 436 / ELE 469 Spring 2013
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L3: Actuator Playground

All lab sections: due ~~3/29/13 at 11:59 PM~~ 4/1/13 at 11:59 PM

Work in your official group for this lab.
Submission procedure and academic integrity guidelines are the same as outlined in the Lab 0 instructions.

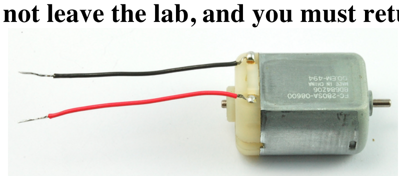
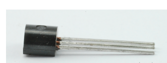
Part 0: Background reading & helpful tutorials

1. Required reading in textbook:
p. 249–259 (motors, up to steppers); browse 271–283 (converting motor motion to usable motion)

2. Optional tutorials, recommended if you get stuck or want inspiration:
How servo motors work:
http://www.jameco.com/Jameco/workshop/howitworks/how-servo-motors-work.html
How DC motors work:
http://www.solarbotics.net/starting/200111_dcmotor/200111_dcmotor2.html
Make: Servos:
http://makeprojects.com/Wiki/Servos

Part 1: DC Motor Control

1. Obtain a DC motor and a PN2222 transistor from the communal supply in the cabinet. **These parts must not leave the lab, and you must return them to the cabinet when you are done with them.**

2. Follow the steps of the DC Motor Tutorial at
http://learn.adafruit.com/adafruit-arduino-lesson-13-dc-motors/overview

You may the alligator clips useful to attach the motor to your jumper wires.

3. Find a classmate and demo for them. **Your classmate should certify that your motor changes speed as you type in different numbers in the serial monitor.** Fill out the peer demo certification form (Lab #3, Part #1).

4. Answer the following questions:

Q1. With your fingers, bring the motion of the motor to a stop. Release it. How powerful is the motor? An informal description is fine.
Q2. Explain, in your own words, why we use a transistor in this circuit.
Q3. Explain, in your own words, why we use a diode.
Record your answers on paper. At the end of the lab, use the Google Form[1] for Lab3 to upload them.

5. Return communal parts to cabinet.

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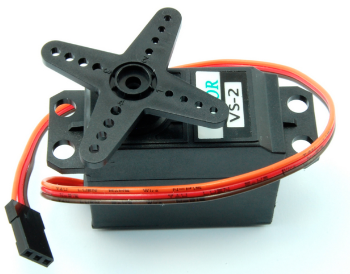
[1] Thanks for voicing your opinions on Google Forms vs. Blackboard. Students were nearly evenly divided on this question, but Google proponents expressed deep-seated Blackboard hatred, whereas Blackboard proponents merely expressed mild annoyance toward Google. For example: "Blackboard is one of the worst pieces of technology that currently exist and should never be used. Logging into it and navigating it is a painful experience that no human should be forced to endure." We basically agree. So back to Google Forms it is.

Part 2: Servo Motor Control



0. Have you really returned your DC motor and transistor to the cabinet? Really? Ok.

1. Grab a servomotor from the communal supply cabinet, along with one or more “horns” to play with (these are the little parts that snap on the top, and look kind of like propellers or hats).

2. Follow the servo tutorial at
http://learn.adafruit.com/adafruit-arduino-lesson-14-servo-motors/parts

3. Now modify the code to make the servo turn in response to input from some other sensor (e.g., a light sensor, piezo knock sensor, thermistor, …)

4. Find a classmate and demo for them. **Your classmate should certify that your servo angle is controlled by some sensor (other than the rotary pot).** Fill out the peer demo certification form (Lab #3, Part #2).

5. Answer the following questions:

Q4. How powerful is the servo, compared to the DC motor?
Q5. What is the range of motion of the servo?
Q6. For what sorts of applications would you choose to use a servo? For what sorts of applications would you choose to use a DC motor? Explain.
Record your answers on paper. At the end of the lab, use the Google Form for Lab3 to upload them.

6. Return communal parts to cabinet.

7. No, really. Put them back in the cabinet.

8. We mean it. Thanks.

Part 3: The Fun Part.

Robots. It’s time to make them. Actually these won’t be full-blown robots, but for this lab you will make your own crawler. **Use any objects you either find or make to create a robot that moves creatively from one point to another.** Whether the robot moves with precision or via a series of random movements is up to you. As always, use the design methodology that you’ve learned to brainstorm and refine your idea. You can use any or all of the technologies that we’ve learned so far.

DO NOT REMOVE SHARED PARTS FROM THE LAB. Do not glue or permanently affix anything to the motors. Tape is fine.

To build this system, you may **only** use parts in the following list. (You are not obligated to use all, or even most, of these parts!)

- Anything from your lab kit
- Communal parts (**must not leave the lab**, must be returned to cabinet before you leave)
  - 1 DC motor (2 if you're extra careful to not remove from the lab, and sensitive to others around you needing to use one)
  - 1 servo motor & horns (2 motors if you're extra careful to not remove from the lab, and sensitive to others around you needing to use one)
  - Misc. resistors
- A reasonable amount of communal materials (paper, cardboard, tape, tinfoil, wire, etc.)
- Any cheap & common materials you bring from home (e.g., paper, Styrofoam, string, coat hangers, toys, food, …?)

What to do:
1. Brainstorm at least 12 ideas of how to make a "creatively-moving robot". Remember to go for volume and encourage wild ideas.

2. Choose one idea. Make a sketch (or a few). Take photos of your sketch(es).

3. Build it.

4. Play with it.

5. Document your completed system in a WordPress blog. Create a new blog post, then:
   a. Add it to the "Lab3" category.
   b. Include the following in your post:
      i. The names of everyone in your group (just first names are fine)
      ii. Your group number
      iii. A short description of what you built, why, and your assessment of its success. You should mention what you liked about the final result, and you should indicate your opinion on what didn't work, or what you might like to do differently. All this text should be **no more than one paragraph**.
      iv. Your list of brainstorming ideas
      v. Photos of your design sketch(es). **Make sure to use the Kaltura plugin for all images & video.**
      vi. Ideally, **video** showing your final system, with short caption(s). If you can't capture video, document with a sequence of photos. **Make sure to use the Kaltura plugin for all images & video.**
      vii. A list of parts used in your final system
      viii. Instructions that would be sufficient for someone else to recreate your design exactly. (This should be no more than one paragraph.)
      ix. Your entire source code for your final "robot" in part 3. If the code isn't too long, copy-paste directly into your writeup, and format the code using either the <pre> tag (if you're in the HTML editing interface) or using the "Preformatted" style, which you can access using the "kitchen sink" button. Or, if you have lots of code, you can upload it somewhere (e.g., Princeton WebSpace) and include a link to it.

6. Hit "Publish" to publish your blog post.

7. Fill out the Google Form for Lab 3 with answers to all the above questions. Also provide your group member NetIDs, your group number, and the URL to your blog. The form URL is here:
https://docs.google.com/forms/d/1Ui_QQQ_92ATvVBWJR0SlCszkXy1A0HgzMwi-r9tDnzo/viewform

8. **Return any communal equipment, tools, etc. to the cabinet. Place your lab kit components in your cupboard and/or take them with you.**

9. No, seriously. Return all of it. Thanks very much.

Grading Rubric:

Parts 1–2: Graded on correct responses to questions and presence of peer demo forms. **Worth 2 points per question, 4 points per peer demo, for a total of 20 points.**
Part 3: **Worth 30 points total.** Graded on:

a) Completeness and quality of documentation: 10 points
   - 0 points: missing/incomplete
   - 6 points: documentation is there but missing key information, missing video/photos+audio, or unclear, or an inappropriate length
   - 10 points: thorough enough for a novice to follow your instructions and re-create easily

b) Documented design process and critical self-reflection: 10 points
   - 0 points: missing/incomplete
   - 6 points: documentation is there but missing some information, or not presented clearly, or an inappropriate length
   - 10 points: includes at least 12 brainstormed ideas, documentation of at least 1 design sketch; includes thoughtful reflection on what worked and what didn't; describes motivation or inspiration for your system

c) Creativity & coolness: 10 points
   - 0 points: bare minimum, looks just like existing tutorials or previous parts of the lab
   - 6 points: result differs substantially from existing tutorials, shows independent thought
   - 10 points: Mind-blowingly awesome; better than anything the TAs would have come up with