COSC 4P78 – Robotics – Assignment 1

Note that this assignment will be requiring electronic-only submission, so keep that in mind for diagrams.
Due: Feb 8, at 17:00 (5pm)

The primary purpose of this assignment is to encourage you to expand the breadth of your general knowledge about components and low-level concepts. Hopefully, this may yield some insight into useful considerations for robotic design.

1. Within the context of sensors, connections, etc. what is meant by *strain relief*?

2. How can a softpot be used to aid in linear motion?
   Include an explanation of the need it's used to address, and how it works. Include a sketch.

3. Concerning TTL vs RS232 serial communication:
   a) Describe the difference(s) between them in terms of how they're actually implemented.
   b) What are each typically used for? i.e. pick a common usage of each, and make sure you choose uses that are actually different from each other.

4. Voltage Dividers have lots of uses.
   i. Providing a reference voltage for analog sensors
   ii. Incorporating resistive sensors to connect to ground for analog sensing
   iii. As the world's most horribly inefficient power supply when a specific voltage is needed
      a) Draw a simple voltage divider
      b) Show how the design can be modified to incorporate a variably resistive sensor (e.g. a force sensisitve resistor) to provide an input for a microcontroller/robot

5. a) What are pull-up/pull-down resistors?
   b) Show a sample wiring for a switch/button, including either a pull-up or a pull-down (your choice)
   c) Why is adding pull-ups not necessarily required when connecting to an Arduino?

6. Concerning DC motors and robotics:
   a) What are flyback diodes? How/why are they used?
   b) Why are capacitors wired across the motor?
   c) Should capacitors wired across motors be electrolytic, ceramic, or does it even matter? Explain!
   d) Name three *completely* different ways to get less speed from a motor. Explain each, and include either a substantial benefit or weakness, depending on which is most appropriate for the technique.

7. Find *any* sensor on robotshop.ca (that lets you do the following).
   a) List the sensor (by name), include the URL, and also the product code.
   b) Find the specifications/datasheet and specify the following:
      i) Input voltage
      ii) Interface used for communication
      iii) Operating current (or min and peak, depending on the datasheet)
      iv) Effective range
   c) List one specific use for which this sensor would be well-suited. Include a brief explanation as to why.
   d) List one specific use for which this sensor would *not* be well-suited, and explain why.
   e) Suggest an alternate to this sensor for the use detailed in (d)

8. Ultrasonic range finders can have numerous problems. List three potential causes of inaccurate readings (or no readings at all, depending on the examples you choose). You'll probably want to include a picture or two.

9. I2C and TWI are terms that can typically be used interchangeably. Briefly detail how the protocol works. Include benefits, limitations, and addressing.

10. A common alternative is SPI. For situations where both are available, why might one wish to use SPI over I2C? What's a significant drawback of SPI that makes I2C attractive?

11. So, we've decided that a voltage divider is a ridiculous way to create any significant power supply. However, assume that the DC voltage we're receiving isn't what we want to provide.

a) I could use a linear voltage regulator for converting to a lower voltage.

i) What would be the biggest downside to that?

ii) What is the most logical/common alternative?

b) I could use a step-up/boost converter for converting to a higher voltage. Explain how these work, and include a diagram.

BTW: If you want a fascinating read, check out the design process behind the Minty Boost: http://learn.adafruit.com/minty-boost/process

12. What is a multiplexer? Why can they be particularly handy when trying to connect several analog sensors to a microcontroller? Feel free to include diagrams.

13. What are opto-isolators for? Include one reasonable example.

14. Assume you want to use PWM from a microcontroller to an actuator. However, suppose this actuator draws too much current for your microcontroller to directly supply. What would be an appropriate component to use as a switching mechanism?

15. “Thing”, from The Addams Family was a disembodied hand that could crawl (and even walk) about on its fingers. If you were able to reproduce Thing in a robot, would it be holonomic, non-holonomic, or redundant? Explain in detail!

16. Pick any possible (simple) task that you might want to use a feedback (i.e. closed-loop) control system for.

a) Fully describe the task, and how you would approach the problem, what you would use for sensor(s), possible problems that might arise, and how you'd address them. Describe/draw a possible solution.

b) Either describe how a PD/PID controller could be useful for that task, or why it really wouldn't be.

c) Could an open-loop control be viable for this task? Either explain why not, or (briefly!) explain how you might approach attempting it with one

17. Consider the task of designing a sensor suite for a find-and-rescue robot. Explain how your selection of sensors would be the same or different depending on whether the robot was rescuing from a burning building (e.g. for firefighters), or for finding stranded skiiers on a mountain. Note: You're just focusing on the sensors; don't worry about how the robot actually moves. However, still be thorough!

18. Consider the task of navigating from one room to another, with a very simple floorplan that includes rooms and hallways, but is entirely orthogonal (i.e. hallways only bend at right angles, and rooms are box-y); that also includes boxes.

a) Explain how the different levels of a hierarchical paradigm might be employed in terms of navigation/locomotion. (That is, explain what might happen at each level)

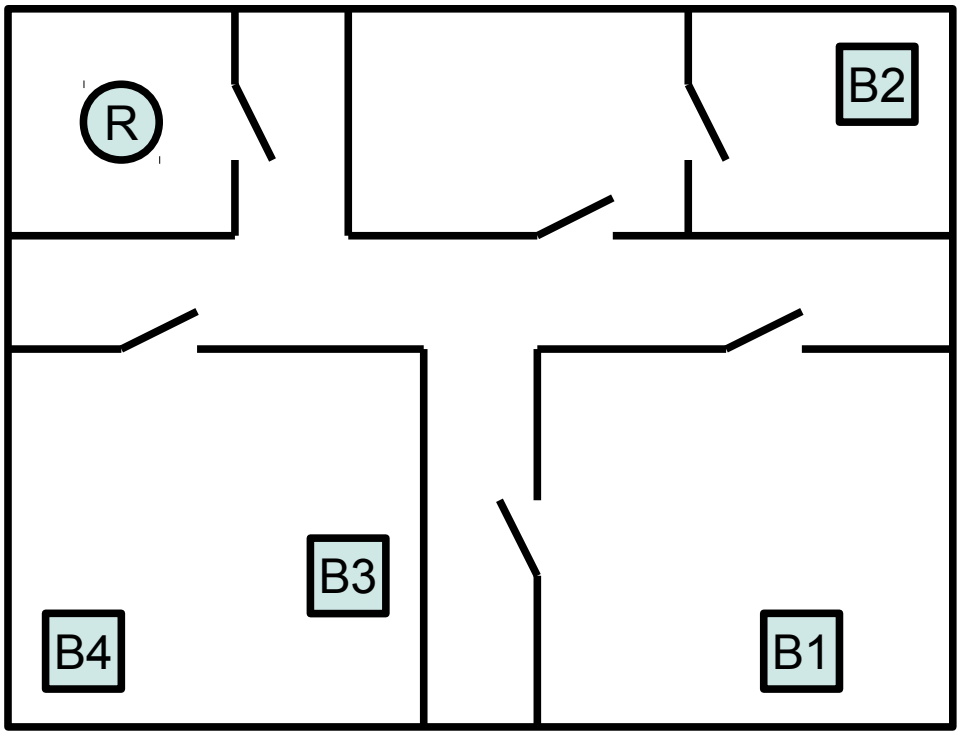
b) Consider how to represent the following room layout, assuming you'd be attempting a Strips-style predicate approach.

i) Explain one method of representing the floor plan, and the world-state as a whole

(i.e.including the boxes/robot), and include an actual sample of the state shown below.

ii) Roughly explain how, using that representation, you could plan navigation of the robot to B1.
Note that you may (and likely will want to) add additional labels

Ensure that you include sufficient detail that you don't exclude doors, etc.



Additional Note:
It's expected that you'll be doing some research to find out about most of these topics, but please remember that "research" does not mean "the Internet wrote it for me".
The goal here is to get used to reading datasheets, researching components, and identifying important considerations when planning a build; not to complete a checklist for a scavenger hunt.

Submission Guidelines:
To submit, throw your file(s) into a folder on sandcastle, and submit it via the `submit4p78` script.
Make sure to only use `.pdf` format.
It's advisable to draw diagrams via software, but scanning in hand-drawn diagrams and embedding onto pages is also fine, so long as they're legible.