COSC 4P78 – Assignment 2

Due: Mon. March 11th, @5:00pm

1. There are many different forms of wireless communication. There are three basic common forms of communication:

i. Broadcasting a single logical value (i.e. *high* or *low*) – when the input into one module is high, so's the output of the other module.
ii. Broadcasting a stream of data (particularly serial) – pump data into one module, and it comes out the other (this is commonly referred to as a *transparent data mode*, because the end-devices actually sending/receiving the data don't need to be aware of the existence of the module at all!).
iii. Packetized data – precisely how it sounds. Data is packaged into discrete packets and broadcast; additional features (that one would expect from actual networking layers) now become possible.

Xbee radios are actually capable of all three of these. (We aren't at the 'question' portion yet; I just thought that was very interesting)
a) Explain what a *wireless sensor network* is. Briefly describe one possible example, and how data could be collected/communicated in it.
b) Briefly describe *mesh networks*. (Note that I'm only looking for roughly a paragraph here; not half a page!)
c) Xbee radios also allow addressing data to either individual recipients, or broadcasting to all that are on the same band. Devise and describe *some* possible multiagent system/application where it might be feasible to require both. (Again, just do this from a very top-level perspective. Describe the actions/tasks; not protocols or detailed minutiae)

2. Design (or describe, if you've found something neat) an *entirely* visual-based method of communication between two or more agents. Caveat: make it simple; either don't use traditional digital cameras as all; or pick something that would work even if they were of sufficiently low resolution to be entirely practical on a typical hobby microcontroller (e.g. arduino). In your answer, briefly describe the task (i.e. what behaviour is being coordinated, or what information is being conveyed), and how the visual signaling would facilitate this.

3. Linear motion is always an interesting topic; it's typically less common in mobile robots, but very useful in automation, as well as CNC-style devices (milling, 3D-printing, etc.).
a) What are worm screws and rack gears? Briefly explain them, as well as some benefit in their use.
b) Pulleys are incredibly common. What sort of motors can be used be used with them?
c) Describe some mechanism for keeping track of (or determining) the precise linear position on a track for some task. Be as detailed as possible, such that someone might hypothetically be able to reproduce this mechanism.

4. We've already discussed several issues with trying to coordinate motion in a robotic arm (e.g. inverse kinematics, etc.). Repositioning the arm typically requires changing the positions of multiple joints simultaneously. It would be preferable to be able to have each of those joints starting and ending motion at the same time; it would also be nice to keep the motion to a reasonable speed.
a) Assume the arm is using hobby servos. Though a microcontroller *could* handle this task by itself, that would be irksome to code, tie up the controller, and essentially be 'reinventing the wheel'. Instead, find a device online that can coordinate multiple servos simultaneously, with either direct control over speed, or the ability to set timing for coordinated actions (or both). Provide a link to a page about that device, and also very briefly describe how it would be used for a task like this.
b) When trying to move an object from position A to position B, even outside of speed/timing, it isn't usually enough to simply tell the arm the new position (B) to be in. Why not?
c) Stepper motors aren't uncommon for moving the joints of robotic arms; actual proprioception isn't really necessary when you've counted the exact number of steps each joint has made. However, gripping an object is a special case, that can't be naïvely coordinated with a stepper motor alone. Why is this? (Note: This is more of a 'thinky' question than a 'researchy' question. It may help to think of theoretical problems with using steppers and gears for the other joints) What's a logical means of solving this problem?

5. Find a machine vision subsystem for either a microcontroller or Mindstorms NXT (or EV3). Include a link for the page. Briefly list/describe some features it provides.
(Note: Yes, I realize this one is incredibly easy. There's no 'trick'; it's just important to remember that these things are an option)

6. Prosthetic limbs have advanced quite a bit over the years. Though they don't receive as much attention as things like self-driving cars, their advancement can be vastly more important to those who rely upon them to reclaim their self-reliance.
a) Briefly explain how myoelectrics (or electromyography) work.
b) Prosthetic hands can exhibit more useful motion than one might expect from the limitations in their control through cleverly chosen *grip patterns*. Briefly describe the concept of a grip pattern, and give a couple of examples.

7. As discussed in class, identifying even the simplest of shapes and structures can be a challenge. For this question, describe an approach for identifying stairs (or some other useful shape of interest) in one of two ways:
i) Briefly describe the different layers of filters and tests you might apply to the image to extract useful information and identify the shapes.
or
ii) Pick *one* of those (e.g. connected-component labeling, or segmentation, or laplace, etc.), and describe it in great detail (~2/3 of a page).

8. By now, you should be closing in on a project idea (or, at least, a rough idea of some field of interest). To get you into the "planning it out" frame of mind, write a short proposal for a *possible* project (*not* necessarily the one you intend to do!)
If Implementation:
Include 5 sections:

i. A *very* brief description of your robot/system/task. If this is more than three sentences long, you're probably doing something very wrong!
ii. Background information on the type of problem you're trying to address – e.g. if you're building an automatic pie-throwing bot to hit people in the face, then you'll want to describe tasks like identifying what a 'face' is, why you need to figure out distances and trajectories, and maybe issues like range finding (particularly if you were using cameras to identify the target).
iii. A cursory overview of approaches. For example, keeping with the pie-in-the-face-er, a brief explanation of how you'd intend to make the pies airborne (perhaps launched out of a cannon? ...please don't actually implement this); maybe haar-like features; etc. Depending on how much you have to explain, this could be anywhere from about a third of a page to an entire page (if it's more, you're probably *severely* overthinking things, or at least overdoing it).
iv. A bill of goods – just the broadstrokes of what you need for building it. Don't worry about accounting for each individual part (for example, don't bother with things like washers unless you're planning on a really unique design that absolutely hinges upon a very *special* kind of washer). For example, you might include things like rails and electromagnets if you were planning on launching your pies with a coilgun ...seriously, don't actually build this. You don't need to include things like expected prices, though you *may* find it handy to do so if you're planning on using this to help prepare for your real project.
v. Expected pitfalls or concerns. This could end up being very short (three or four sentences), or very long (a third of a page), depending on how many things you can foresee going wrong (like, say, your coilgun-launched pies following unpredictable trajectories, having to hide from the police for pastry-related homicide, or, like, providing sufficient current or other more practical concerns). Hopefully I don't need to tell you this, but if you end up filling up an entire page with this stuff, *obviously* that's a sign that you shouldn't do it for real! (The same goes for whether or not you're forced to use the term, "pastry-related homicide")

If Written Report:
Include 4 sections:

i. A *very* brief abstract of your topic. I just want to know the topic. One sentence is good, two is fine, three is acceptable.
ii. Slightly more detail on your topic; not in terms of *how* things work, but more likely problems or tasks that would likely be addressed in the eventual paper. Try to focus more on problems than solutions; and if you do include references to solutions, don't try explaining how they work.
iii. A list of subtopics that you'll probably have to cover. (In other words, topics related to either your main topic, or the techniques you'll have to discuss as a result) For each, include a brief description; ideally in a single sentence apiece.
iv. A list of references. Note: Wikipedia is not a reference. If you don't have *at least* a dozen references here, you probably haven't thought about the problem enough yet. Also: Wikipedia is not a reference. Even if you don't end up using this topic, it's still helpful to get practice finding information on esoteric subjects. Additionally: Wikipedia is not a reference.

Note that the *written report* version is probably shorter than the *implementation* version; that doesn't necessarily mean it's easier – I expect you to put more thought into which subtopics are relevant; for the implementation I'm just expecting that you've started trying to work out which pieces to mash together, possibly without even having figured it out yet.

To be clear, this isn't necessarily for *your* project; just *a* project. There'll be absolutely no comparison made between your proposal and your actual project; you don't even have to make the Implementation/Report aspect match up with the real thing.

Submission:
You know the drill. Electronic submission only; pdf format (feel free to scan in any illustrations, etc.). Use the `submit4p78` script on sandcastle.