CSCE 496/896-003: Real-Time Systems HW #3

Assigned: 2016-02-15
Due: 2016-03-04 in class or by email by end of day

Homework Overview

The objective of this homework is primarily to solidify the concepts of modeling and how they relate to good system design. I strongly suggest you get started on this homework right away. At least do the first two parts in the first week. Those two are both low-effort endeavors.

Administrative notes:

- In the syllabus I said each of the 5 homework assignments would be worth $\sim 10\%$ of your grade. I will weight this homework a bit more, probably $\sim 20\%$ as it will likely prove to be the most difficult and time-consuming homework. This means the other homework assignments will be weighted $\sim 7.5\%$ of your grade.
- You may **not** work in teams on this homework since it's unrelated to the project. Please do your own work and turn in your own assignment.

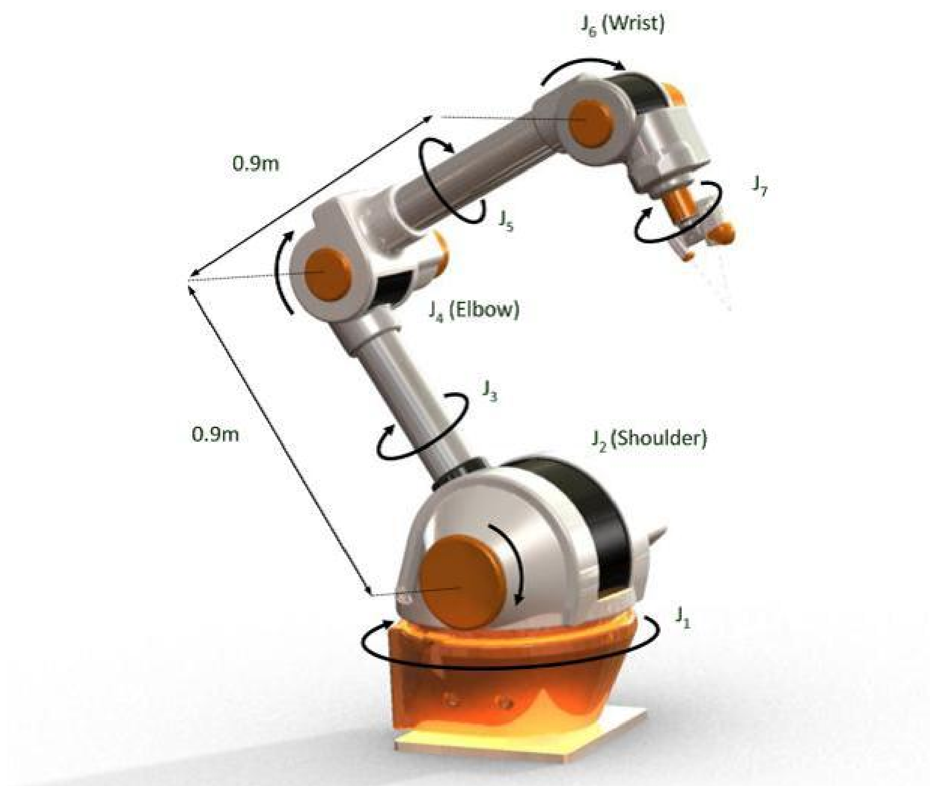
Expected Outcomes (what I want you to learn)

- How to read and synthesize a scientific article (if you've never read one)
- Gain practice in applying our real-time model to a proposed system
- Provide feedback on the course so I can improve it

Deliverables (what you turn in) and Grading

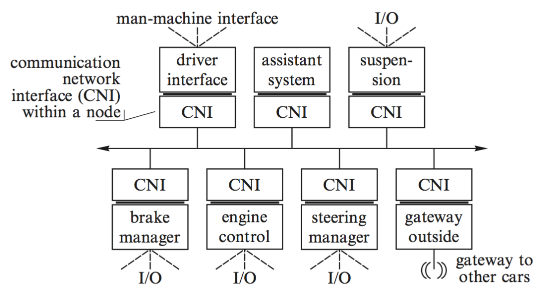
- 10 points - Take the survey at `http://goo.gl/forms/qimFMSwSdK` by 2016-02-19
  - NOTE: there is no mechanism in the form for you to put your name. That way you can be honest in the form. But that also means I won't know whether or not you actually filled it out. So please indicate in your homework whether or not you completed the survey.
- 20 points - read and synthesize [1] (posted to Blackboard). Pay particular attention to the notes and highlights I've made
  - Describe three difficulties in system integration of RTS
  - Describe three methods for improving system integration techniques of RTS
  - What was good in this paper?
  - What could be improved in this paper?
  - Helps:
    - If you don't know how to read and synthesize a scientific paper read
      - this for amusement `http://www.sciencemag.org/careers/2016/01/how-read-scientific-paper`
      - this for a more serious approach "How to Read a Scientific Article" by Mary Purugganan and Jan Hewitt (posted on Blackboard)

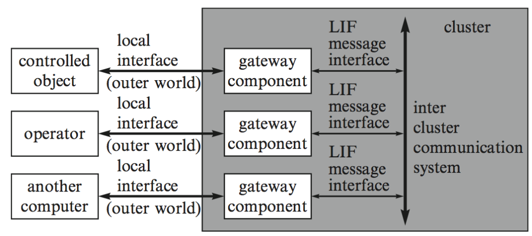
- 70 points - apply our RTS modeling techniques to a system
  - System description: the system in question is an articulated robotic arm. It has many joints consisting of motors, sensors, etc.



  - 10 points - identify the components you will need and justify the reasoning
    * Give each component a clear purpose
    * Suggest 1 or 2 computational tasks (algorithms) that would run on each component you identify
  - 10 points - identify the messages each component will send and justify the reasoning
    * Make sure to specify for each message whether it will be event-triggered or time-triggered. Will it be an atomic message, or broken up (as in TDMA)?
    * Give an outline of what the message will contain (what will be in the header, data, and trailer)
    * Since you don't have information about the actual autonomous algorithms involved (or their timing) make some assumptions about the timing requirements and indicate them for purposes of your design. For example, assume the motor controller must update at a 30 Hz rate and incorporate that into your timing specs. What does this mean for how often you must read the sensors?
  - 30 points - design the LIF, local interface, and TII (don't worry about the TDI)
    * Tell me about the level of detail at which you've chosen to apply the real-time model abstraction and why you chose it. What details are you excluding? What assumptions are you making about the person who implements your system design? What problems will they encounter?
    * It's possible the TII will be very similar for many of the components.

  * It's possible some components won't have a local interface if they don't interact with the external environment
  * Use the "Linking Interface Specification" section 4.6 in the book (we went over this in class) to help you design the interfaces
  * With each part of the interfaces describe "where" the interface specification lives (e.g. in the message, in memory, in a database, etc.)
- 20 points - sketch a system layout similar to ones we've seen in class. You may need multiple sketches (depending on your design choices), one showing components, one showing interfaces, one showing clusters. These are examples from the book:





- Notes and details:
  * Remember, system design is a subjective thing...there isn't a **right** answer. However, I will grade based on your application of the RT model we've been discussing. I will **not** dock you points for any design decisions you make **as long as you describe why you made the decision** and it's not unreasonable. You must have all the elements: components, messages, and interfaces, but you need not provide so much detail that this part of the assignment requires 40 hours worth of work. Rather than doing this assignment by trying to figure out what I'm looking for, approach this homework with all your creative faculties. I'm "looking for" well-thought-out solutions here, not a particular answer.
  * If you don't know what exactly would go into an articulated robot arm I would strongly suggest doing some Googling to figure out how it might work. At a bare minimum there must be a motor and a sensor for each rotating part (remember the feedback loop I've drawn in class a few times). Consider the following sources:
    · `https://en.wikipedia.org/wiki/Industrial_robot#Robot_programming_and_interfaces`
    · `http://www.societyofrobots.com/robot_arm_tutorial.shtml`
  * You are **not** designing any of the intelligence in this robot. It doesn't matter how the robot moves, what algorithms plan its trajectory, or how the controller works...someone else designed that. You are **solely** focused on the real-time computing aspect of the robot arm.
  * Remember I expect something typed up, including the diagrams and interfaces. Some suggested programs for "drawing" the diagrams are: PowerPoint, Keynote, Visio. But feel free to use whatever program you want.

References

[1] J. Sztipanovits, X. Koutsoukos, G. Karsai, N. Kottenstette, P. Antsaklis, V. Gupta, B. Goodwine, J. Baras, and S. Wang, "Toward a science of cyber-physical system integration," *Proceedings of the IEEE*, vol. 100, no. 1, pp. 29–44, 2012.