Lab 7. "Segway" Motion Control Contest.

Deliverables: **Each lab group must submit a *short* (~2-3 page) Multi-media Lab Report, which includes a movie or animation of an impulse response, by 5pm Thurs., May 19 (in the dropbox).** Include the following:

1. Document your overall controller to stabilize and to drive the robot forward. Include the following: gains used, how wheels are controlled to stay synchronized, and a plot of the reference trajectory you used (for wheel velocity). Also, describe briefly how you tuned gains. (e.g., LQR Q and R matrices used, or any overall scaling to the K gains you may have tried, etc.)

2. **Be sure to save log data!** Also, either video tape your robot or create a MATLAB animation, based on log data. (Video taping is easier!) In your report, include plots of body angle and wheel angle(s) over time, including response to an external perturbation. (i.e., an impulse response, where you tap the robot and then let it recover.) Identify the dominant poles of the actual closed-loop system, *based on experimental data*.

3. Also include a plot (on the same axes as part 2 is preferred, but no required) an impulse response for your *predicted* closed-loop system *based on your model*, using MATLAB. Does the impulse response agree with your predicted closed-loop poles?

Overview and Contest Description

This week, your mission is to control the robot both to remain upright and to move along a prescribed trajectory as quickly as possible. Being able to stay upright while also being able to drive is a good test of your controller.

For fun, as with previous robot projects, we will hold an in-class contest, with rules and scoring to be announced by the TA's. The winning team will receive a $25 amazon.com certificate, to be awarded (with previous awards) during our end-of-term presentations of Final Projects.

Specific suggested tasks to work on include:
1. Continue to tune your state space controller for the inverted pendulum robot.
2. Implement additional control to synchronous wheel rotations with one another.
3. Implement motion control, to command desired velocity for the wheels over time.
4. Smooth your reference trajectory (for velocity as input above), to go from A to B quickly.

TA's can help in designing a simple wheel synchronization strategy. Reference tracking can be implemented much as it was for the omnibot, only we now suggest you command wheel velocity and include an integrator in your model to calculate desired wheel position. This will result in reference trajectories for both wheel position and wheel velocity.

Grading and creativity guidelines

Credit for the lab includes check-off by TA (40%), and a lab report (60%). We hope to obtain short video documenting several different robot controllers. The assignment requires that you have completed the tasks listed below. **We are flexible about how you approach particular problems; feel encouraged to be creative and use whatever knowledge and ideas you have.** *Please be concise and efficient in your presentation; well-labeled plots are always appreciated – and often can be much more effective in communicating details than excessive text.*