Professor Fearing   EECS192/Assignment #2   Spring 2014
Due by 5 pm Fri. April 4 in 725 S.D. Hall.

(One assignment per team.) Simulink model for the car is provided on the class web page under "Course". A function is also provided which provides lateral distance from track. For all plots, time axes should be in seconds, and lateral errors in m or cm. Do not use the white-on-black screen dump in Simulink (which wastes toner). Instead use "to workspace" block and plot in Matlab.

For each part below, plot on 1 page a) actual x vs y position of car b) lateral error y_a as function of time, c) steering angle δ as function of time. For part 5, below, also plot d) car longitudinal velocity as a function of time. For each part, list constants used. (k_p should have units of radians/meter, etc.)

(20 pts) 1. Steering Simulation- ideal car
a. Using the nonlinear Matlab simulation, with speed 3 m/s, plot car performance using pure position control, $\delta = k_p y_a$. (Find "best" k_p.) Specify worst-case overshoot (cm).
b. Use the nonlinear Matlab simulation, with speed 3 m/s, plot car performance using position + derivative control, $\delta = k_p y_a + k_d \dot{y}_a$. Find k_p and k_d which give reasonable performance. Specify worst-case overshoot (cm).

(35 pts) 2. Steering Servo Speed and Sensor Resolution
(15 pts) a. Estimate the slew rate limit (rad/sec) or time constant for your servo. You can estimate delay of your steering linkage using a Hamamatsu optical sensor, a wire contact sensor, or a cell phone video.
(15 pts) b. For your line camera mounting location and orientation, estimate track position resolution Δ (in cm) which is limited by the 128 elements. Standard deviation due to position quantization can be estimated as $\sigma = \frac{\Delta}{\sqrt{12}}$.

For each problem below, explain controller used, including constants. Initial condition: starting off the track with an initial 10 cm position and 10° orientation error. You are welcome to use P-D control or another controller of your choice. For each part below, specify overshoot (cm). If needed, you can reduce the speed below 3 m/sec but then state what speed was used.

(25 pts) 3. Steering simulation - slew rate limit
Use the nonlinear Matlab simulation, and slew rate limit found in 2a above, plot best car performance. What is worst case overshoot? What is laptime?

(25 pts) 4. Steering simulation with slew, quantization, and speed control
Switch the simulink block diagram to use car speed control rather than a fixed speed. For example, decelerate when the lateral error is large, and speed up when tracking well. Use the nonlinear Matlab simulation, plot best car performance. Specify value of k_v.
What is worst case overshoot? What is laptime?

Case	Slew Rate Limit (rad/sec)	sensor noise σ (mm)	Car velocity set point m $\cdot sec^{-1}$
1. ideal	1000	0.0	3
3. Servo limit	tbd	0.0	3
4. Speed change	"	tbd	$V_o - k_v|y_a|$ for $|y_a| < V_o/k_v$

Table 1: Parameters for simulation test cases. tbd are estimates for your car from part 2. V_o is nominal set speed with no error.