MASSACHVSETTS INSTITVTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science
6.01—Introduction to EECS I
Fall Semester, 2007

Remarks on Feedback for Lab 6

Why large gains cause problems

As you probably discovered, the gains you found by fixing the natural frequencies to all be $2/3$ are near 1000. Such gains are not practical to use on the robot because of noise problems.

To see the problem, consider an example. Suppose $k_1 \approx 1000$ and $k_2 \approx -900$. Then when you compute the angular velocity, the result will be

$$1000 * e(n) - 900 * e(n-1).$$

Now suppose the robot is heading parallel to the walls and is in the center of the corridor, so $e(n)$ should equal $e(n-1)$ should equal zero. If the optical sensors make random errors on the order of milimeters (roughly a twenty-fifth of an inch), a typical case might be that $e(n)$ equals 0.001 instead of exactly zero, and $e(n-1)$ might be equal to -0.001 instead of exactly zero. These small noise errors will generate an angular velocity of 1.9, and spin the robot way off course.

Since noise will limit the gains you can use to magnitudes of no greater than about twenty, you will discover that you can not find gains that will reduce the magnitude of the maximum natural frequency to much below one. You will also find that the magnitude of the maximum natural frequency will not change much for a variety of different gains that cause the robot to have very different performances. The natural frequencies do not tell the whole story in this case, and you should think physically about what is going on. If you have time, you can plot difference equation solutions (try using initial conditions of all ones, indicating the robot is pointing parallel to the center, but away from it). Talk to your LA.