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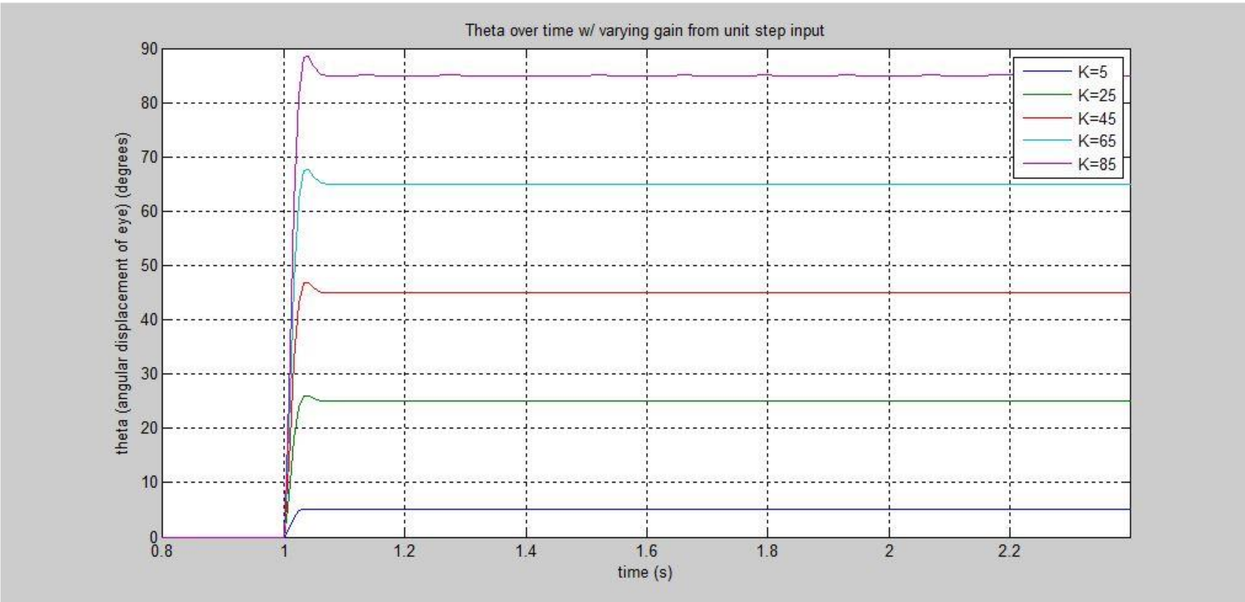
CLAB 2: Westheimer Model of Oculomotor Movement

Using Westheimer's model values of 120degrees/s for the un-damped natural frequency and 0.7 for the damping ratio, I varied the gain (K) with the following values: 5, 25, 45, 65, and 85. A given value of gain combined with the unit step input gave saccades of magnitude equivalent, in degrees of angle displacement, to the gain. See **Graph 1**. The gain clearly controlled the settled magnitude of the saccade. Although the magnitude of the overshoot seemed to increase a little as K increased, each overshoot looked proportional to the magnitude of the settled saccade.

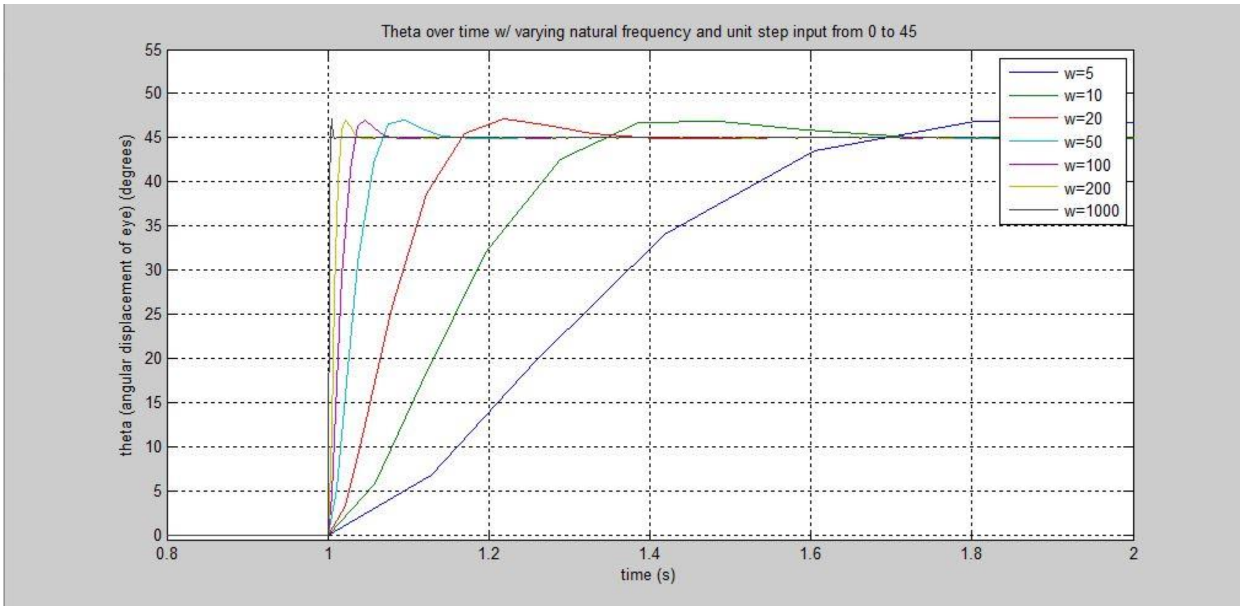
Graph 1



For the rest of the analysis please note that the final saccade I was looking to replicate, from Physical Lab 2, was the 45degree saccade. Accordingly, I varied the un-damped natural frequency (w) and the damping ratio (z) while using a constant gain value of 45 in combination with the unit step input. When varying the un-damped natural frequency I used 0.7 for the damping ratio and the following values for w: 5, 10, 20, 50, 100, 200, and 1000. The result of increasing w was an increase in the responsiveness of the saccade to the forcing function. See **Graph 2.** In other words the saccade's rise time decreased, or occurred much quicker for higher values of w. The eye accelerates quicker and reaches the overshoot magnitude, as well as returns to the settled magnitude, much faster. The magnitude of the overshoot remains the same regardless of this responsiveness however. This surprised me as I would have figured a faster accelerating system would reach a higher velocity, increasing the magnitude of the overshoot.

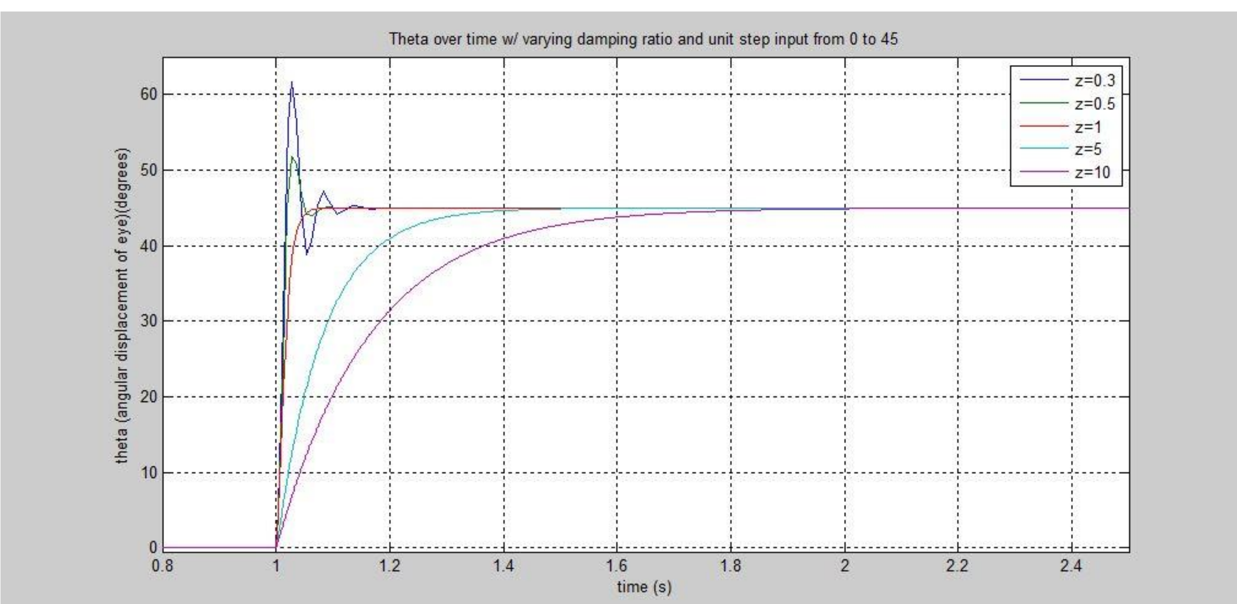
But I suppose if the system's ability to accelerate is so dramatically affected, so may be its ability to decelerate. Final resting magnitude of the saccade did not change with varying w values either.

Graph 2



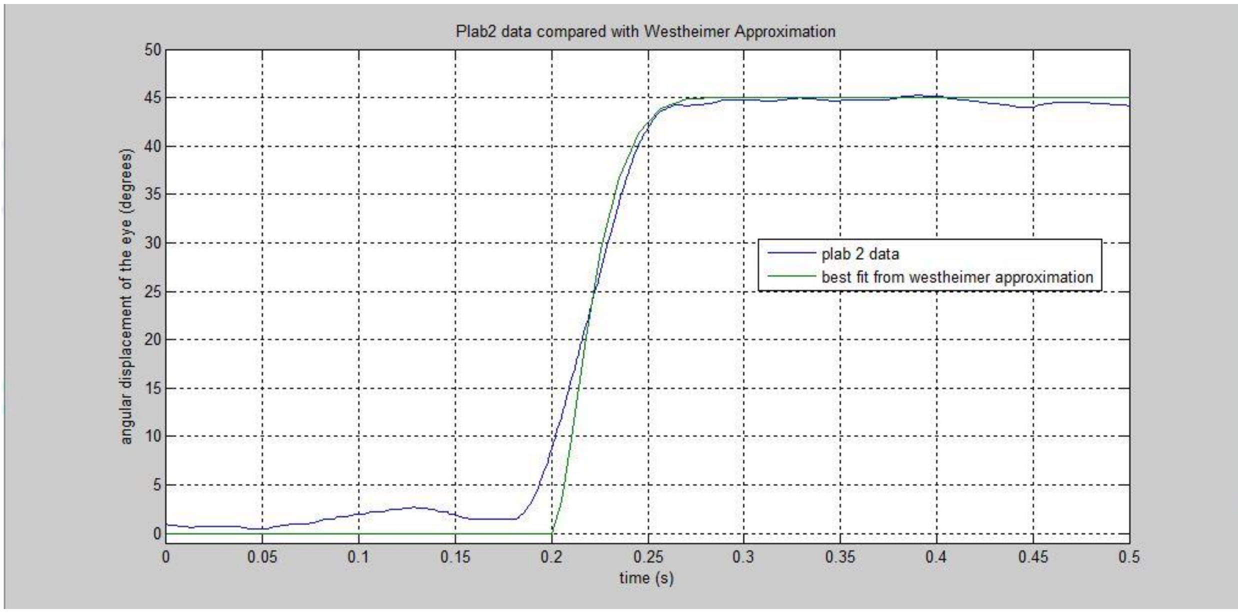
Again using 45 for K and now using 120degrees/s for w, I varied the damping ratio (z) with the following values: 0.3, 0.5, 1, 5, 10. I saw behavior from under-damped to critically-damped and over-damped. The effect of increasing the damping ratio was an increase in damping/ a decrease of overshoot and oscillation. See **Graph 3**. However in combination with decreasing oscillation is the increase in rise time to the first intercept with the desired saccade magnitude. This 2nd function is similar to a decrease in w. For this reason I think the two factors are necessary. Say you're after a very quick rise time with no overshoot. You can't achieve that with either of w or z changes alone. Both are required.

Graph 3



Comparing the computational model to my physical data from Plab2, I was able to get a pretty close match…. surprisingly close actually (it's really cool when things work like they're supposed to☺). To draw the two graphs closer I used the following parameter values: K=45, w=80, z=0.9. See **Graph 4**. This gave me the closest match I could accomplish without the use of intelligent matching software, which I was not familiar with enough to implement. Overall the Westheimer model account for eye dynamics extremely well.

Graph 4



Last Notes:

If it's relevant, here is the simple process used to find a conversion function from voltage to displacement angle. See **Graph 5.**

Graph 5

Voltage Difference	Angle
0.456	45
0.37	23
0.2125	11
0.11	5