**Milestone One: Fun with LEDs**

**CS-350**

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In this lab, we changed the frequency and duty cycle of a pin configured as a pwm and attached this pin to an LED’s positive connection. In doing so, we were able to observe a change in perceptible flicker (persistence in perceived vision) and brightness.

**1. At what frequency is the flicker noticeable?**

At every frequency below 60 Hz, we were able to observe flicker at lower duty cycles (<= 50%), but this flicker becomes increasingly more difficult to recognize as frequency increases for any duty cycle > 30%. This implies that either brightness or actual time that the particles producing the light remain excited play almost as significant a role in persistence of vision as does the frequency at which we excite those particles.

**2. At what duty cycle is the intensity of the LED perceptibly diminished as compared to 50% duty cycle?**

This is difficult to answer objectively, since we did not test multiple LEDs at different duty cycles side by side. The author perceives a difference at the recommended 5% intervals, as discrete steps can be seen easily while the program is looping. Again, this also depends on chosen frequency, as the steps were much more noticeable at lower frequencies (~ <= 60 Hz).

**3. Were the 5% increments smooth?** **If not, what could be done to make them appear more smooth?**

As described above, the perceived smoothness increased in a positive correlation with frequency. To increase the perceived smoothness, one could choose a smaller interval or reduce the amount of time in each duty cycle (for instance, by changing the time.sleep(0.1) to a shorter period of time). This would reduce the actual difference in intensity between steps and give the brain less time to perceive differences in intensities, respectively.

**4. What functions set the PWM frequency for a GPIO line?**

GPIO.PWM() sets the intial pin and frequency for the PWM. ChangeFrequency() also changes the frequency of the PWM.

**5. What functions set the duty cycle for a GPIO line?**

What a boring question. The start() function sets the initial duty cycle and the ChangeDutyCycle() function does as its name implies.