PID Tuning Constants Calculation

Step Test Parameters

K = Motor Gain in %/%

T = Loop time in seconds

Ts = Settling time in seconds

Td = Delay time in seconds

$$T_d' = T_d + \frac{T}{2}$$

Analog PID Parameters

$$K_P = \frac{1.2T_s}{KT_d'}$$

$$K_I = \frac{0.6T_s}{KT_d'^2}$$

$$K_D = \frac{0.6T_s}{K}$$

Digital PID Parameters

$$K_P' = K_P$$

$$K_I' = K_I * T$$

$$K_D' = \frac{K_D}{T}$$

$$K_1 = K_P' + K_I' + K_D'$$

$$K_2 = -K_P' - 2 * K_D'$$

$$K_3 = K_D'$$

Digital Control Law:

$$u[k] = u[k-1] + K_1 * e[k] + K_2 * e[k-1] + K_3 * e[k-2]$$

Tips:

1. Exercise precaution when using excel to compute the step test parameters, especially with regards to timestamps of data
2. Ensure loop time is exactly as per 'T' used in above calculation
3. Feedback (wheel RPM) should be computed using interrupt based method instead of pulseIn
4. All calculations of input/feedback/output must be in % scale. The output needs to be scaled into normal range when sent to motors
5. For starting and stopping, use linear ramp of wheel speed instead of PID control
6. For calculation of Ts and Td, 2-point method is more accurate than tangent-method (LINK)
7. If feedback noise is high, simple software filter may be used to reduce this