

47510W Phoenix Horizon Programming

Contents

1 PID

A PID Controller (Proportional–Integral–Derivative Controller) is a control system that brings the system softly to a target, preventing overshoots and making for a more accurate program. PID controllers are used within our program to make more accurate turns and allow fine control over the amount the robot moves.

1.1 How Does a PID Controller Work?

Each term, P I D , each serve a specific role in creating and controlling and input which is used to reach the target. By adding up the values of the terms we get the input. We will analyze the function of each term individually.

P Term The P (Proportional) increases the input proportionally to the distance to the target. In other words, the farther you are from your target the larger the P Term is. P is the error, or distance from the target. We calculate the value of P with the following formula.

$$P = T - M$$

Where T is target and M is the measured current value

The P Term is the primary way of tuning the PID and is always the first step. The specifics of tuning and how we tune each term will be discussed in a later section.

I Term The I (Integral) is the cumulative error. The I term increases as the program runs and increases faster if farther away from the target. Which allows the controller to power over an obstacle, most often friction close to the target. We calculate the value of I with the following formula.

$$I = I_0 + P$$

Where I_0 is the I term from the previous cycle, and P is the current error(The P term)

D Term The D (Derivative) is how fast the error is changing. The D term helps bring the controller out of a oscillating state caused by repeated overshoots, as are often induced by the P term. We calculate the D term with the following formula.

$$D = P - P_0$$

Where P is the error(P term) and P_0 is the previous error (last P Term)

Putting It Together To the get the input that we feed to our system, usually a motor for our purposes, we add together our three terms. Each of which multiplied by its tuning information. Tuning specifics will be covered in the next section. Our input formula is as follows.

$$R = P \cdot P_k + I \cdot I_k + D \cdot D_k$$

Where R is the output(or return), P I and D are the calculated values, and P_k I_k and D_k are the tuning values

1.2 Tuning A PID

For a PID to properly reach the target it must be tuned. Inadequate tuning can lead to failure to reach the target or aggressive oscillations. We tune a PID by changing tuning parameters, these parameters are called P_k I_k and D_k . The first step is to set all tuning parameters to 0. As in the previous section we will look at the tuning of each term individually.