ISSN 2229-5518

PID Controllers for Line Tracing Robots

Rajarshi Godse, Aishwarya Murkute, Prof. Reena Kharat

Abstract— "PID" is an acronym for Proportional Integral Derivative. Main task of the PID controller is to minimize the error of whatever we are controlling. It takes in input, calculates the deviation from the intended behavior and accordingly adjusts the output so that deviation from the intended behavior is minimized and greater accuracy obtained. Line following seems to be accurate when carried out at lower speeds. As we start increasing the speed of the robot, it wobbles a lot and is often found getting off track. Hence some kind of control on the robot is required that would enable us to make it follow the line efficiently at higher speeds. This is where PID controller can be used. This paper demonstrated in detail how to employ the PID method to line tracers. The proposed approach had superior features, including easy implementation and good computational efficiency.

Index Terms—PID Algorithm, ID controller, PID Controller types, PID design, PID Controller parameter, PID tuning

1 INTRODUCTION

For a nonlinear non-stationary system with possible noise and uncertainties, as well as various design/operational constraints, the solution to the optimization problem is by no means trivial. Classification of Controller There are mainly three types of controllers

- Proportional controllers.
- Integral controllers.
- Derivative controllers

Combinations of these three controllers are written below:

- Proportional and integral controllers.
- Proportional and derivative controllers
- Proportional integral and derivative controllers.

The proportional controller is one in which the actuating signal is directly proportional to the error signal. The integral controllers are the controllers in which the actuating signal is directly proportional to the integral of the error signal. The derivative controller is one in which the actuating signal is directly proportional to the response derivative of the error signal. PD controller improves the transient response of the system. PI controller reduces the steady state error present in the system. PID controller is the combination of PD and PI controller. The PID controller algorithm involves three separate constant parameters i.e. P, I & D. PID controller operates directly on error signal which is the between desired output and actual output. By tuning the three parameters in the PID controller algorithm, the controller can provide control action designed for specific process requirements. The response of the controller can be described in terms of the responsiveness of the controller to an error, the degree to which the controller overshoots the set point, and the degree of system oscillation.

2 LITERATURE SURVEY

A) Design of PID controller

One of the most common controlling methods in the market is the PID controller. Application of the PID controller involves choosing the KP, KI and KD that provide satisfactory closed-loop performance. These parameters must be selected so that the characteristics, settling time and proper overshoot rate, all of which guarantee the system stability, would be satisfied.

ISSN 2229-5518

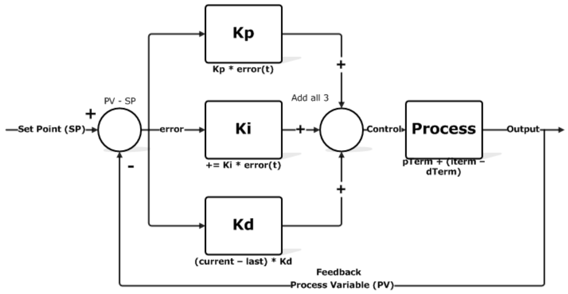

Figure 1:PID Controller

The basic terminology in PID are:

Error - The error is the amount at which a device isn't doing something right. For example, suppose the robot is located at x=5 but it should be at x=7, then the error is 2.

Proportional (P) - The proportional term is directly proportional to the error at present.

Integral (I) - The integral term depends on the cumulative error made over a period of time (t).

Derivative (D) - The derivative term depends rate of change of error.

Constant (factor)- Each term (P, I, D) will need to be tweaked in the code. Hence, they are included in the code by multiplying with respective constants.

P-Factor (Kp) - A constant value used to increase or decrease the impact of Proportional

I-Factor (Ki) - A constant value used to increase or decrease the impact of Integral

D-Factor (Kd) - A constant value used to increase or decrease the impact of Derivative

PID Formula

Proportional: Difference = (Target Position) - (Measured Position)
Proportional = Kp*(Difference)

Derivative:

Derivative provides the rate of change of error. This helps to know how quickly the error changes from time to time and accordingly set the output.

Rate of Change = ((Difference) – (Previous Difference))/time interval
Derivative= Kd *(Rate of Change).

The time interval can be obtained by using the timer of microcontroller. The integral improves steady state performance, i.e. when the output is steady how far away it is from the set point. By adding together all previous errors it is possible to monitor if there are accumulating errors. For example- if the position is slightly to the right all the time, the error will always be positive so the sum of the errors will get bigger, the inverse is true if position is always to the left. This can be monitored and used to further improve the accuracy of line following.

Integral:

Integral = Integral + Difference
Integral = Ki*(Integral)

Summarizing "PID" control-

Term	Expression	Effect
Proportional	Kp x error	It reduces a large part of the error based on present time error.
Integral	error dt	Reduces the final error in a system. Cumulative of a small error over time would help us further reduce the error.
Derivative	Kd x derror / dt	Counteracts the Kp and Ki terms when the output changes quickly.

Table 1.1: PID Summary

Therefore, Control value used to adjust the robot's motion= (Proportional) + (Integral) + (Derivative)

B) PID Tuning

In PID implementation constant values are tuned depending on the platform the robot is intended to run on. The physical environment in which the robot is being operated vary significantly and cannot be modelled mathematically. It includes ground friction, motor inductance, center of mass, etc. Hence, the constants are just guessed numbers obtained by trial and error. Their best fit value varies from robot to robot and also the circumstance in which it is being run. The aim is to set the constants such that the settling time is minimum and there is no overshoot.

C) Algorithm

Start with Kp, Ki and Kd equaling 0 and work with Kp first. Try setting Kp to a value of 1 and observe the robot. The goal is to get the robot to follow the line even if it is very

ISSN 2229-5518

wobbly. If the robot overshoots and loses the line, reduce the Kp value. If the robot cannot navigate a turn or seems sluggish, increase the Kp value.

Once the robot is able to somewhat follow the line, assign a value of 1 to Kd (skip Ki for the moment). Try increasing this value until you see lesser amount of wobbling.

Once the robot is fairly stable at following the line, assign a value of 0.5 to 1.0 to Ki. If the Ki value is too high, the robot will jerk left and right quickly. If it is too low, you won't see any perceivable difference. Since Integral is** cumulative, the Ki value has **a significant impact. You may end up adjusting it by .01 increments.

Once the robot is following the line with good accuracy, you can increase the speed and see if it still is able to follow the line. Speed affects the PID controller and will require retuning as the speed changes.

Effects of increasing parameters independently:

Parameter	Rise-time	Overshoot	Settling time	Steady state error	Stability
KP	Decrease	Increase	Small change	Decrease	Degrade
KI	Decrease	Increase	Increase	Eliminate	Degrade
KD	Minor Change	Decrease	Decrease	No effect	Improve

Table 1.2 Effects of increasing parameters

CONCLUSION

It is shown graphically that there is a substantial improvement in the time domain specification in terms of lesser rise time, peak time, settling time as well as a lower overshoot. Hence by varying different parameters of the PID controller the response of the system is changing. Hence by changing kp, ki, and kd the response of the system is improved. Also, the peak Nayak, et al., International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974 Int. J. Adv. Eng. Res. Studies/IV/II/Jan.-March,2015/346-350 overshoot, the rise time and the settling time of the system is reduced. Hence this method is a design method for determining the PID controller parameters. It can obtain higher quality solution with better computational efficiency

3 REFERENCES

[1] [1] S.M. GirirajKumar, Deepak Jayaraj, Anoop.R. Kishan," PSO based Tuning of a PID Controller for a High Performance Drilling Machine" 2010 International Journal of Computer Applications (0975 - 8887) Volume 1 – No. 19

[2] [2] Zwe-Lee Gaing, "A particle swarm optimization approach for optimum design of PID controller in AVR system", IEEE transactions on energy conversion, November 6, (2002).

[3] [3] Gowrishankar Kasilingam," Particle Swarm Optimization Based PID Power System Stabilizer for Synchronous Machine" World Academy of Science, Engineering and Technology International Journal of Electrical, Computer, Electronics and Communication Engineering Vol:8 No:1, 2014

[4] H. I. Abdul-Ghaffar, E. A. Ebrahim, M. Azzam," Design of PID Controller for Power System Stabilization Using Hybrid Particle SwarmBacteria Foraging Optimization" WSEAS Transactions on Power Systems

[5] Mahmud Iwan Solihin, Lee Fook Tack and Moey Leap Kean," Tuning of PID Controller Using Particle Swarm Optimization (PSO)." Proceeding of the International Conference on Advanced Science, Engineering and Information Technology 2011 Hotel Equatorial Ban Putrajaya, Malaysia, 14 - 15 January 2011. ISBN 978-983-42366-4-9 K Ogata, Modern Control Systems, University of Minnesota, Prentice Hall, 1987.

[6] Gaing, Z.L. (2004). A particle swarm optimization approach for optimum design of PID controller in AVR system. IEEE Transaction on Energy Conversion, Vol.19 (2), pp.384-391.

[7] G. Shabib, Mesalam Abdel Gayed, And A.M. Rashwan," Optimal Tuning of PID Controller for AVR System using modified particle swarm optimization" Proceedings of the 14th International Middle East Power Systems Conference (MEPCON'10), Cairo University, Egypt, December 19-21, 2010, Paper ID 170

ISSN 2229-5518

ISSN 2229-5518