Proceedings of the 2023 International Conference on Mechatronics and Smart Systems
DOI: 10.54254/2755-2721/11/20230272

The control of proportional parqmeters helps in production and living

Jingyi Dong

Northeast Electric Power University, Jilin, 132012, China

2194636722@qq.com

Abstract. PLC, or programmable logic controller, is a type of microprocessor-based digital computing controller. It can be used for automatic control, storing and executing control instructions loaded into memory at any moment. In the process of classroom learning, the author learned about PLC, and the device to implement PLC is PLD, that is, a programming logic device, whose letters represent proportional controller, integral controller, and differential controller. In the process of learning, people noticed that proportional control is relatively simple compared with integral and differential control, but it is the most frequently used and widely used, so the author can't help but have a strong interest in proportional control. Through research and search, the working principle and working characteristics of the PLC were found because it has high reliability, convenient programming, adaptable setup, full input/output functional modules, and quick processing speed, which are used by many modern precision instruments. In the process of research, it was found that it was the K value that affected the proportional control, and the simulation using the false data image found that the model curve formed under different K values was also very different. Therefore, the research topic of this paper is the transformation of different graphics caused by the change of proportional control K in the PLC. The plots obtained by different K values are different, and the advantages and disadvantages of proportional control can be found.

Keywords: K values, scale control, flowchart, result curve.

1. Introduction

The author discovered via classroom study that PLC, as a precision controller, offers many benefits that other controllers cannot match and permeates all facets of production and daily life, particularly numerous precision devices. By conducting research and organizing pertinent literature, the author discovered that while few articles teach the fundamentals of PLC, the majority of them concentrate on the unique applications of a given instrument or its great performance in a given area. Perfect; Everything has benefits and drawbacks, and in order to get the most out of something, people must be aware of both, take advantage of the benefits while avoiding the drawbacks.

This article will introduce in detail the proportional control in PLC, that is, the different transformations caused by K values, and analyze its advantages and disadvantages according to different K value images through standard indicators, so as to make better use of them. It is hoped that through the research of this paper, it will provide direction for the application and development of future instruments.

2. The composition of PID

The most frequently used types of control in works are differential, integral, and proportional. And PID control, often referred to as PID regulation, can be used to refer to all of these. It has a roughly 70-year history and has emerged as one of the capital talents because to its attributes such as simplicity, consistency, dependability, and ease of change. The most convenient situation is when determining the structure and parameters of the system controller depends on experience and on-site debugging because it is impossible to fully understand the structure and parameters of the controlled object, it is difficult to obtain an accurate mathematical model, and other technologies of control theory are difficult to adopt. That is, PID control technique is best suited when we do not fully grasp a system and the controlled object or when we are unable to gather system parameters using efficient measurement methods. In addition to PI and PD controls, there is PID control. The PID controller bases its decisions on the system's error and calculates the control quantity using proportional, integral, and differential methods [1].

First of all, in order to know the nature of an object, it is important to understand how it is composed. It is known that what will be learned is proportional control in PID, and for a better visual description, a software called falsed is used here.

The figure below shows an op amp, the basic building block of a proportional controller in this software. A differential amplification circuit with a high input resistance and the ability to prevent zero drift makes up the input stage of an operational amplifier, an electronic integrated circuit with a multi-stage amplification circuit; The intermediate stage typically consists of a common-emitter amplification circuit, performs voltage amplification in its primary function, and has a high voltage amplification factor. The output electrode has a low output resistance and a high load capacity. It is connected to the load. For the op amp to form a basic proportional control unit, resistors need to be added to its input and feedback terminals, and the K value of the proportional control is determined by the ratio of these two resistors:

$$K = a/b$$

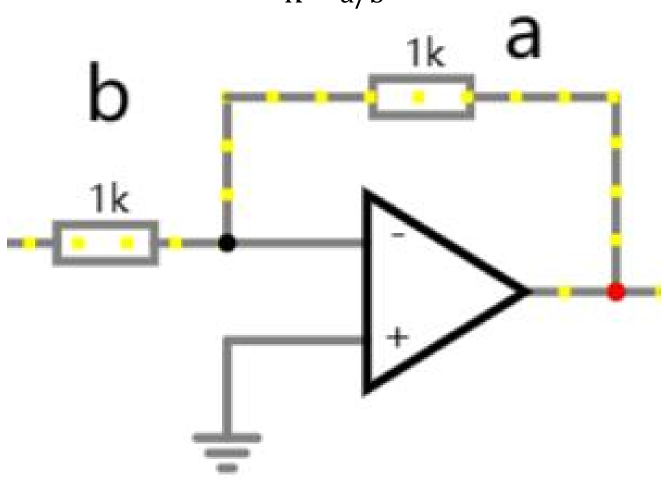

Figure 1. Proportional controller.

The simplest type of control is proportional control, in which the controller's output signal proportionally mirrors its input signal. Its purpose is to modify the system's open-loop gain, enhance its steady-state accuracy, decrease its inertia, and quicken its reaction.

3. Conclusion curves

Proportional control is actually a controller to ensure that the system is stable due to negative feedback, so a loop should be built here to make it counterproductive.

In order to determine the different curves obtained by different K values and present them more clearly, you need to use false software to first establish a logic loop. Here, use a DC motor-voltage and

DOI: 10.54254/2755-2721/11/20230272

integrator to form a unit with an expression of 3/[(ts+1)s], and then connect with the proportional controller to obtain the corresponding image. The following figures show the image when the K value is 0.5, 1, 5, and 50.

The K values selected here are the most representative images in the area.

Figure 2 is the image generated when the K value is 0.5. In the figure, we can clearly see that the output curve is a stable rising and then flattening curve, its maximum value does not exceed the stable value, no overshoot. But the speed of reaching the stable value is a bit slow (t=5.194).

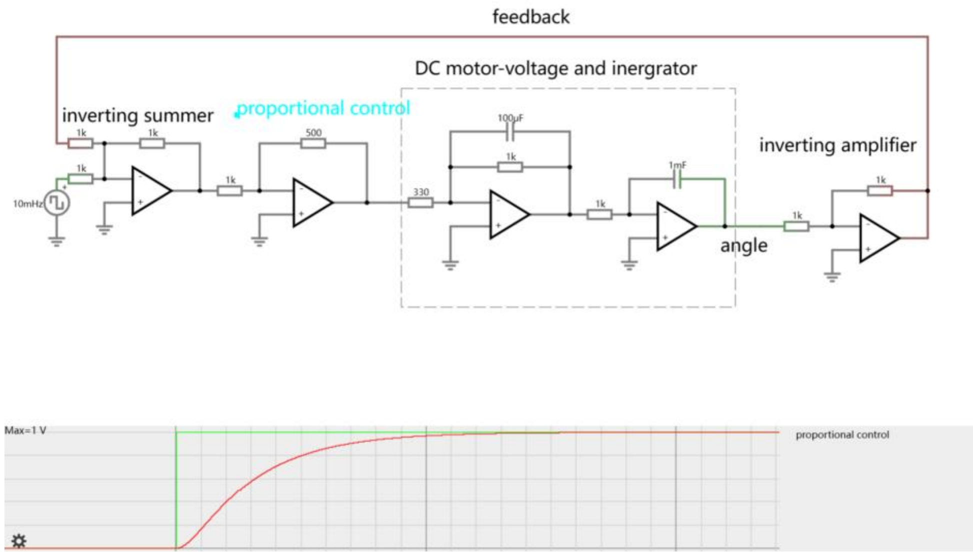

Figure 2. Graphical curve with a value of K of 0.5.

Figure 3 is the image produced when the K value is 1, and compared to the previous image, it is clear that it has a much shorter time to reach the stable value, only 4.444s, and there is also no overshoot.

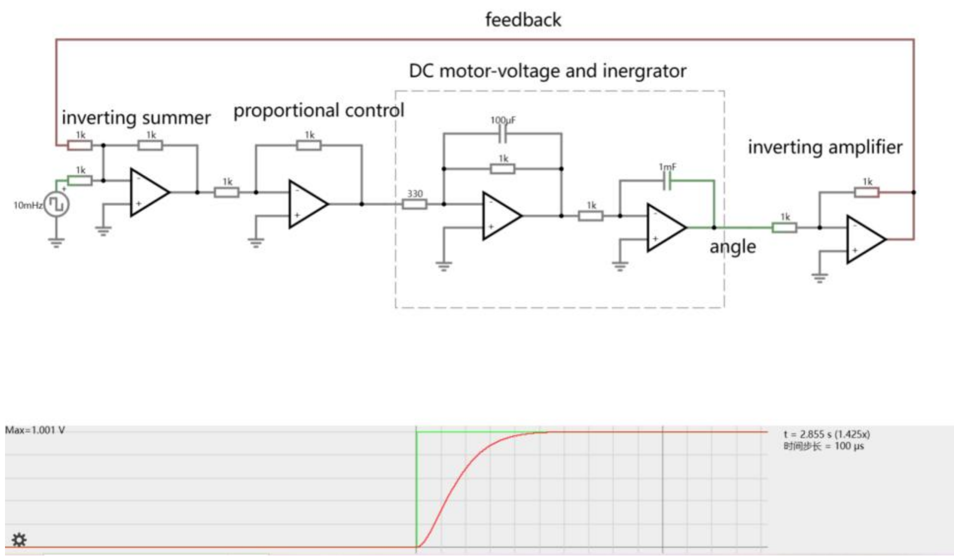

Figure 3. Graphical curve with a value of K of 1.

Figure 4 is the image when K is 5, it can be found that there is an overshoot at this time, but the overshoot is not very large, and the overshoot at this time is 1.248V-1.000V=0.248V. The time to reach the stable value is 4.408s.

DOI: 10.54254/2755-2721/11/20230272

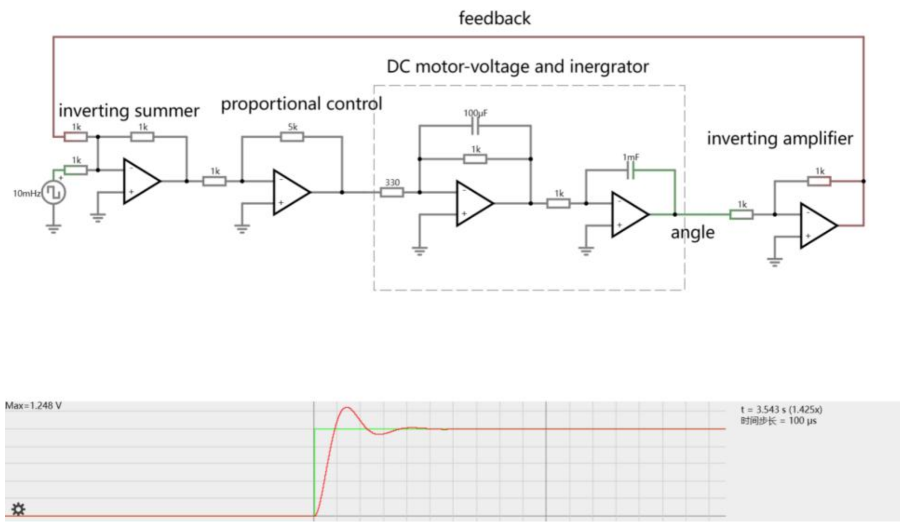

Figure 4. Graphical curve with a value of K of 5.

Figure 5 is the image when K is 50; at this time the overshoot increases, 1.374V-1.000V=0.374V, and the graphics oscillate very strongly, and the final stabilization time is 4.544s.

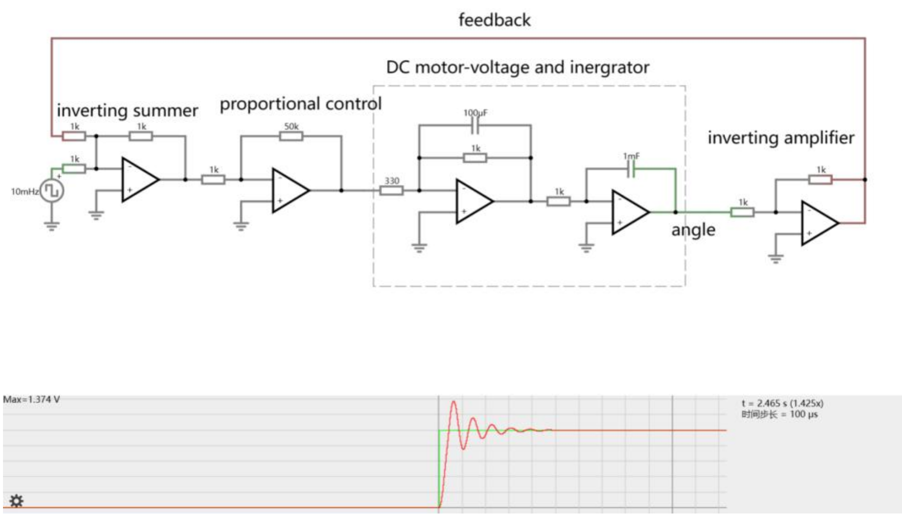

Figure 5. Graphical curve with a value of K of 50.

4. Advantages and disadvantages

It is known that the standard indicators for judging a controller are stability (whether the system finally tends to be stable), accuracy (small dynamic deviation is better), and speed (whether it tends to be stable quickly). From the image, it is clear that the system is a stable system, with the following specific analysis: accuracy and rapidity [2].

Accuracy: In the image below the picture, you can see that the Max of all images is different, where K=0.5 and 1 have the same maximum value and are the most accurate, while K=5 and 50 are first beyond the stable value and then gradually stabilized, wherein the maximum value of K=5 is 1.248V, and the maximum value of K=50 is 1.374V, which obviously shows that K=5 is more accurate [3].

Rapidity: The time step of each image in the above figure is 100us, which can control the variables well, and when you look directly at the figure, you can find that the image of K=0.5 is significantly slower than K=1, while the images of K=5 and K=50 will first exceed the stable value and then gradually stabilize. However, for a more rigorous verification, on the right side of the image, one can see the stability time at different K values, t=5.194s when K=0.5, t=4.444s when K=1, t=4.408s when K=5, t=4.544s when K=50. It is clear that the rapidity is not good when the K value is too large or too small, and the speed is better when the K value tends to 5 [5].

5. The future development

Through the advantages and disadvantages of proportional control, people can choose a more suitable K value. Let PID be better applied in production and life. In terms of the robot manipulator, its benefits and drawbacks are used to determine the ideal course of time, and the actuator characteristics, such as motor speed and acceleration, are more fully guaranteed. By comparing simulation and experiment results, the effectiveness and efficiency of the suggested optimization strategy are confirmed.[6] Control of any system is important, and the same is true in chemical process systems, and COMSOL programs and simulates an adaptable system for the chemical processing sector. The proportional integral differential control algorithm maintains the correct level of concentration and velocity behavior for the same type of fluid applied from both channels. To reach the desired concentration, the controller can modify the fluid's flow rate. When a high proportional gain factor is used, the response performs well when testing various PID coefficients. The best responsiveness of the process to concentration and velocity data was found to occur when kp = -1 m4/(mols). Low proportional gain levels result in excessive overshoot and steady-state errors in the system response.[7] PID control is also used in medical equipment. Medical equipment as one of the main means of modern auxiliary doctors to cure patients, requires extremely high precision, so reasonable analysis of the advantages and disadvantages of proportional control, can achieve better results.[8] Almost everywhere automation can be used, PID will make it more convenient and fine, such as in ship dynamic positioning[9], Multi-rotor UAV trajectory tracking based on fuzzy adaptive neural PID controller[10], etc.

6. Conclusion

Through the above analysis, individuals are able to better understand proportional control and observe the formation of different result curves due to changes in K, so that the advantages and disadvantages of proportional control can be determined.

It can be seen that proportional control has a fairly simple structure, including only resistors and op amps, so it is easy to modify. But simple structures tend to expose shortcomings, such as the tendency to overshoot when K is greater than 1, which can cause circuit components to fail due to tip pulses, which most often occurs when the first peak or valley exceeds a fixed voltage.

The current disadvantage of this paper is that the sample of K-value data is not large enough, because this paper selects the most representative K-value curve for analysis according to the change of the graph curve, and does not list more. Through the advantages and disadvantages of proportional control, one can choose a more suitable K value. Let PID be better applied in production and life.

References

[1] ZHOU Aqun. Principle and application of PLD for programmable logic devices. Geophysical Equipment, 2007(10):44-47,48.
[2] LI Guolin. Research and optimization design of parameter tuning technology of PID controller. Dalian:Dalian University of Technology, 2011:6.
[3] Devia Narváez D, Devia Narváez D, Ospina R. Optimal proportional control applied to direct current motor. Journal of Physics: Conference Series, 2019(11).
[4] Yang Yi, Cui Kaixin, Shi Dawei, Mustafa Ghulam, Wang Jiadong. PID control with PID event triggers: Theoretic analysis and experimental results. Control Engineering Practice, 2022.
[5] Pratama G N P, Setiawan N, Saputra S A, Pambudi L, Umam A D N, Hermansah M N P. Optimal Quadratic Regulator PID for Motor DC. Journal of Physics: Conference Series, 2022.

DOI: 10.54254/2755-2721/11/20230272

[6] Chen Guangrong, Wei Ningze, Yan Lei, Lu HuaFeng, Li Jin. Time-optimal trajectory planning based on event-trigger and conditional proportional control. PloS one, 2023(1).
[7] Ertugrul Ishak. Application of PID controller in chemical process system using COMSOL. Journal of Mechatronics and Artificial Intelligence in Engineering, 2022(12):107-113.
[8] Keren He, Liwei Jiang. Research on DC Electronic Load System Based on BP Neural Network PID Control. Academic Journal of Engineering and Technology Science, 2022(12).
[9] Gopmandal Falguni, Ghosh Arun, Kumar Avinash. LQ optimal robust multivariable PID control for dynamic positioning of ships with norm-bounded parametric uncertainties. Ocean Engineering, 2022(11).
[10] Mendoza Abigail María Elena Ramírez, Yu Wen. Fuzzy Adaptive Control Law for Trajectory Tracking Based on a Fuzzy Adaptive Neural PID Controller of a Multi-rotor Unmanned Aerial Vehicle. International Journal of Control, Automation and Systems, 2023(1):658-670.