Comparative Study of Different Classifications for PID Algorithm

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Abstract— Automation is the use of PID controller algorithm is simple, stable, easy adjustment and high reliability, Conventional control system used in conventional PID control .Most of industrial processes with different degrees of nonlinear, parameter variability and uncertainty of mathematical model of the system. Tuning PID control parameters is very difficult, poor robustness; therefore, it's difficult to achieve the optimal state under field conditions in the actual production.

Key words: PID controller,

I. Introduction

Automation is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated. The biggest benefit of automation is that it saves labour; however, it also used to save energy and materials and to improve quality, accuracy and precision.

II. Process Control System

The process control system is the entity that is charged with the responsibility for monitoring outputs, making decisions about how best to manipulate inputs so as to obtain desired output behavior and effectively implement such decisions on the process [1]. The process has a property called self-regulation. A self- regulating system does not provide regulation of a variable to any particular reference value. In process control, the basic objective is to regulate the value of some quantity. To regulate means to maintain that quantity at some desired value regardless of external influences. The desired value is called the reference value or set point. In many industrial process control systems, the control process is complex in mechanism, and varying with time. So, general PID control is very difficult to obtain satisfactory effects because it is not self-adaptive for many varying factors such as parameter varying. The process dynamics are concerned with analyzing the dynamic i.e., time dependent behavior of a process in response to various types of inputs. In other words, it is the behavior of a process as time progresses [2, 3].

III. Classification of PID

PID is a common feedback loop component in industrial control system. The controller takes a measured value from a process or other apparatus and compares it with a reference set point value. The difference or "error" signal is then used to adjust some input to the process in order to bring the process' measured value to its desired set point. Unlike simpler controllers, the PID can adjust process outputs based on the history and rate of change of the error signal. This gives more accurate and stable control. In contrast to more complex algorithms such as optimal control theory, PID controllers can often be adjusted without advanced mathematics. However, pushing robustness and performance to the limits required a good understanding of the theory and controlled process [4,5].

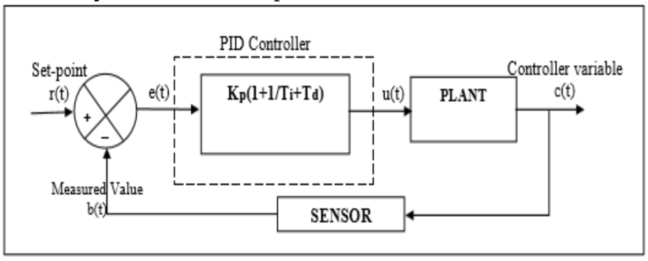

Fig. 1: Block diagram of PID based control system

A PID controller is called a PI, PD or P controller in the absence of respective control actions. The PID algorithm can be implemented in several ways. The easiest form to introduce is the parallel or "non-interacting" form, where the P, I and D elements are given the same error input in parallel. e(t) is the Set point – Measurement (t) is the error signal and Kp, Ti, Td are constants that are used to tune the PID control loop.

IV. Tuning Methods of PID

Performance of PID depends on the gain parameters. so we need to adjust them .Different methods are used as open loop method and close loop method.The Open loop method a step to the process and get the response and deadtime ,reaction rate and process gain then by putting the controller in manual mode, wait until the process value (Y) is stable and not changing Step output of the PID controller - The step must be big enough to see a significant change in the process value.

V. Closed Loop Method

A. *Ziegler–Nichols method*

PID tuning method is designed by Ziegler-Nichols (ZN) and is based on the systems step response of the closed-loop system under pure proportional controlled, the gain is increased until the closed-loop system becomes critically stable. At this point the ultimate gain K is recorded together with the corresponding period of oscillation as the ultimate period. Based on these values Ziegler-Nichols calculated the tuning parameter.

B. *Cohen-Coon Method*

Perform a step test to obtain the parameters of a FOPTD (first order plus time delay) model.Make sure the process is at an initial steady state.Introduce a step change in the manipulated variable.Wait until the process settles at a new steady state. Calculate process parameters. Using the process parameters, use the prescribed values given by Cohen and Coon.

C. Tyreus-Luyben Method

Same as steps 1 to 4 in Ziegler-Nichols method as presented above and Evaluate control parameters as prescribed by Tyreus and Luyben.

D. Auto tune Method (Closed-loop On-Off test)

Let process settle to a steady state.Move the set point to the current steady state.Implement an on-off (relay). Let the process settle to a sustained periodic oscillation controller. Evaluate ultimate gain using auto tune formulas. Use either Ziegler-Nichols or Tyreus-Luyben prescribed tunings.

E. Manual tuning

If the system must remain online, one tuning method is to first set K_i and K_d values to zero. Increase the K_p until the output of the loop oscillates, then the K_p should be set to approximately half of that value for a "quarter amplitude decay" type response. Then increase K_i until any offset is corrected in sufficient time for the process. However, too much K_i will cause instability. Finally, increase K_d, if required, until the loop is acceptably quick to reach its reference after a load disturbance. However, too much K_d will cause excessive response and overshoot. A fast PID loop tuning usually overshoots slightly to reach the set point more quickly[6,7]; however, some systems cannot accept overshoot, in which case an over-damped closed-loop system is required, which will equire a K_p setting significantly less than half that of the K_p setting that was causing oscillation.

F. Overview of methods

There are several methods for tuning a PID loop. The most effective methods that are generally involve the development of some form of process model, and then choosing P, I, and D based on the dynamic model parameters. Manual tuning methods can be relatively time consuming, particularly for systems with long loop times. The choice of method will depend largely on whether or not the loop can be taken "offline" for tuning, and on the response time of the system. If the system can be taken offline, the best tuning method often involves subjecting the system to a step change in input, measuring the output as a function of time, and using this response to determine the control parameters.

VI. DAMPING OSCILLATION

Damping is an influence within or upon an oscillatory system that has the effect of reducing, restricting or preventing its oscillations. In physical systems, damping is produced by processes that dissipate the energy stored in the oscillation[8.9]. The damping of a system can be described as being one of the following.

A. Overdamped oscillation

The system returns (exponentially decays) to equilibrium without oscillating.

B. Critically damped oscillation

The system returns to equilibrium as quickly as possible without oscillating.

C. Oscillation

The system oscillates (at reduced frequency compared to the undamped case) with the amplitude gradually decreasing to zero.

D. Undamped oscillation

The system oscillates at its natural resonant frequency (ω_o).

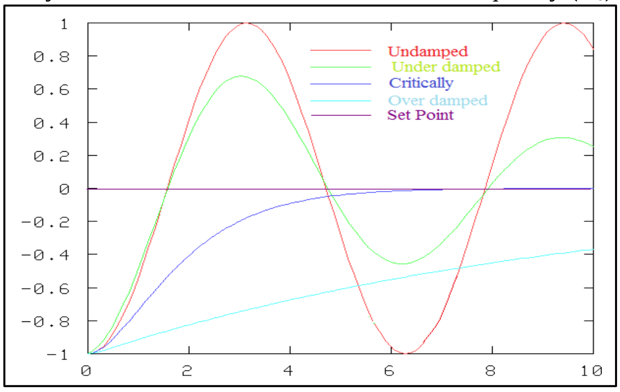

Fig. 2: Different Damping Oscillations

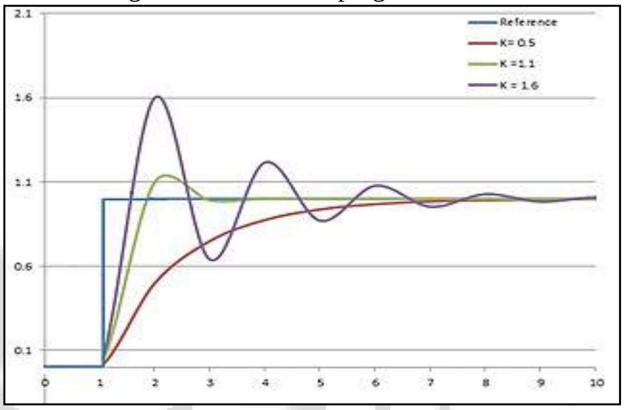

Fig. 3: Oscillations for K_P

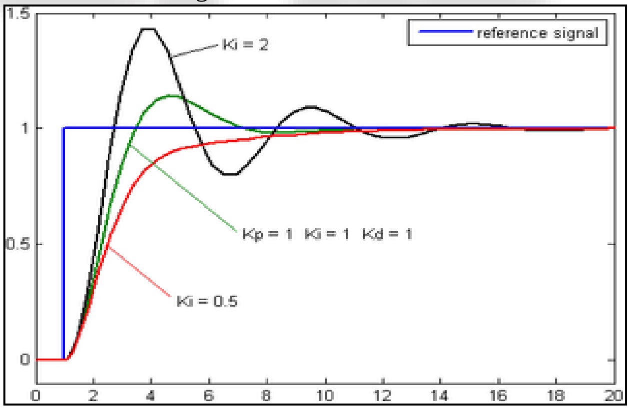

Fig. 4: Oscillations for K_i

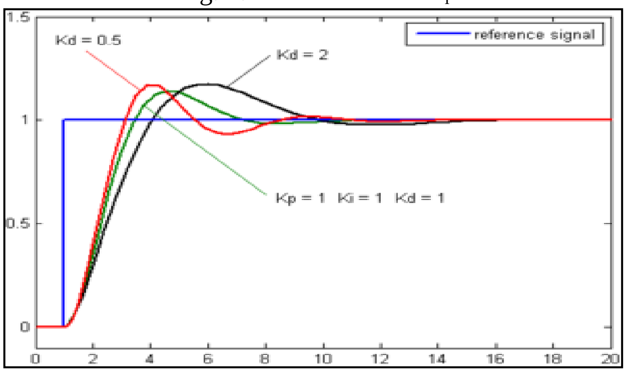

Fig. 5: Oscillations for varying K_d

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Dr.G.Prathyusha received M.Sc and P.hd degrees from the Department of Instrumentation and USIC, SriKrishna Devaraya University ,Anantapur. She having eight years of teaching experience. Her area of interest are Network and Mobile Communications, network security systems, and embedded systems.

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