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Proposed Approach on CSTR with PID

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Abstract— ***In this paper conventional PID controller provides satisfactory results, still inefficiency persists due to extreme non-linear nature and uncertainty in the dynamics of the plant. So optimize the pid non linear behavior by Gravitational search algorithm and particle swarm optimization. The PID controller is the most common form of feedback. PID control issued at the lowest level; the multivariable controller gives the set points to the controllers at the lower level. The PID controller can thus be said to be the "bread and butter' of control engineering. It is an important component in every control engineer's tool box. PID controllers have survived many changes in technology, from mechanics and pneumatics to microprocessors via electronic tubes, transistors, integrated circuits.***

Keywords— PID controller, CSTR, Optimize, PSO

I. INTRODUCTION

A proportional-integral- derivative (PID) controller is a commonly used in industrial control systems. A PID controller continuously calculates an error value as the difference between a desired set point and a measured process variable. The controller attempts to minimize the error over time by adjustment of a control variable, such as the position of a control valve, a damper, or the power supplied to a heating element, to a new value determined by a weighted sum Where k p, K i and K d all non negative, denote the coefficients for the proportional, integral and derivative terms.

Dead time or time delays are found in many processes in industry. In fact most tuning methods for PID controllers used in industry consider dead times as an integral part of process dynamics models. Dead times are mainly caused by the time required to transport mass, energy or information, but they can also be caused processing time or b accumulation of time lags in a number of simple dynamic system connected in series. Dead times produce decrease in the system phase and also give rise to a non-rational transfer function of the system making them more difficult to analyze and control. Because of this characteristics dead time control problems have attracted the attention of engineers and researchers who have developed a special type of controller like PID controllers, Smith Predictor(DTC), MPC and various algorithms to control dead times.

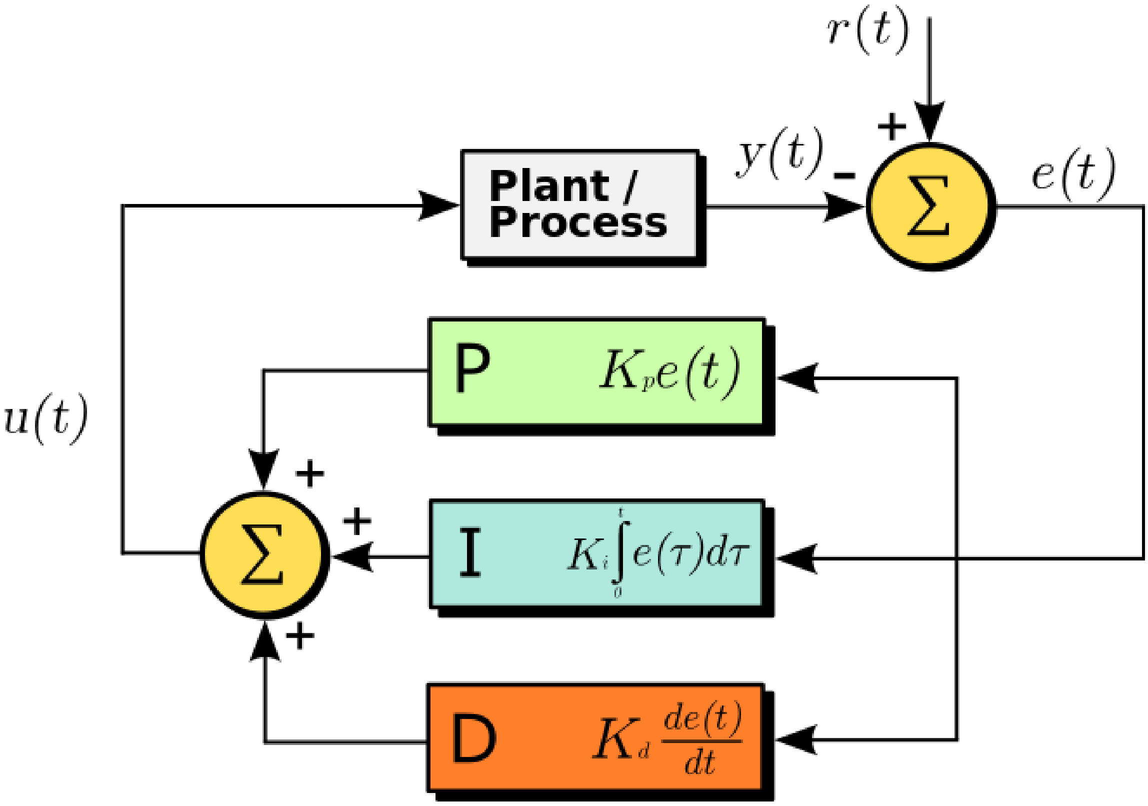

Figure 1: Block diagram of a PID controller in a feedback loop

As a PID controller relies only on the measured process variable, not on knowledge of the underlying process, it is broadly applicable [22]. By tuning of the three parameters of the model, a PID controller can deal with specific process requirements. The response of the controller can be described in terms of its responsiveness to an error, the degree to which the system overshoots a set point, and the degree of any system oscillation. The use of the PID algorithm does not guarantee optimal control of the system or even its stability.

II. LITERATURE REVIEW

Ali Zribi et al[1]: In this paper, a novel adaptive tuning method of PID neural network (PIDNN) controller for nonlinear process is proposed. The method utilizes an improved gradient descent method to adjust PIDNN parameters where the margin stability will be employed to get high tracking performance and robustness with regard to external load disturbance and parameter variation. Simulation results show the effectiveness of the proposed algorithm compared with other well-known learning methods.

A. Jayachitra and R. Vinodha [2]: Genetic algorithm (GA) based PID (proportional integral derivative) controller has been proposed for tuning optimized PID parameters in a continuous stirred tank reactor (CSTR) process using a weighted combination of objective functions, namely, integral square error (ISE), integral absolute error (IAE), and integrated time absolute error (ITAE). Optimization of PID controller parameters is the key goal in chemical and biochemical industries. PID controllers have narrowed down the operating range of processes with dynamic nonlinearity. In our proposed work, globally optimized PID parameters tend to operate the CSTR process in its entire operating range to overcome the limitations of the linear PID controller. The simulation study reveals that the GA based PID controller tuned with fixed PID parameters provides satisfactory performance in terms of set point tracking and disturbance rejection.

MeeraViswavandya [3]: This paper proposes the application of fractional order PID controller (FOPID) for reactive power compensation and stability analysis in a stand-alone micro grid. For enhancement of voltage stability and reactive compensation of the isolated system, a SVC based controller has been incorporated. This paper emphasizes the role of fractional PID based SVC controller for reactive power management and improved stability in the stand alone micro grid, as it provides a special advantage of having two more degree of freedom for accurate tuning in comparison with the conventional controller The system performance, particularly the variations in different parameters values are studied properly with different input parameters and loading conditions. Further improvement of stability margin and optimisation of the system parameters have been achieved by the controller, based on Imperialist competitive algorithm.

Geetha M et al [4]: Tuning the parameters of a controller is very important in system performance. Ziegler and Nichols tuning method is simple and cannot guarantee to be effective always. In order to overcome the parameter uncertainties, enhance the fast tracking performance of a process system, a brand-new two-dimension PID fuzzy controller, fuzzy PI+ fuzzy ID, is proposed in this paper. The self-tuning fuzzy PI+ fuzzy ID controller is fast; computing on-line easily and can reduce stability error. To demonstrate the advantages of the fuzzy PI+ fuzzy ID controller, has been applied to an application in the control of Continuous Stirred Tank Reactor (CSTR) level loop. The simulation and real-time implementation were executed and its results show that the proposed control scheme not only enhances the fast tracking performance, but also increases the robustness of the system. From the simulation it is clear that there is substantial improvement in the Self-tuning Fuzzy PID controller in terms of peak overshoot, settling time, peak time, rise time, Integral Square Error (ISE) and Integral Absolute Error (IAE).

Jau-Woei Perng et al[5]: In this study, the stochastic inertia weight particle swarm optimization (SIWPSO) algorithm and radial basis function neural network (RBFNN) methods were used to identify the optimal controller gain for the fractional order proportional integral derivative (FOPID) controller of time-delay systems; furthermore, a graphic approach was used to plot 3D stability regions in the k p, ki , and kd parameter space. This paper presents an intelligent SIWPSO-RBF algorithm for identifying the optimal solution for a FOPID control system. To explain how to use the SIWPSO-RBFNN method, this paper presents two cases describing how the proposed algorithm can be useful in FOPID-type controllers with two fractional-order time-delay systems. Furthermore, the proposed algorithm can be used in two desired procedures if the system transfer functions are known. The first procedure involves identifying the optimal k p and ki gains while kd varies and the parameters λ and μ are known. The second procedure involves identifying the optimal k p, ki and kd gains while λ and μ vary. Finally, several simulations of the proposed algorithm verified the effectiveness of a FOPID controller regarding fractional-order with time-delay systems.

J.C. Basilio et al. [6] proposed methodologies for tuning PI and PID controllers. Like the well-known Ziegler- Nichols method, they are based on the plant step response. The methodology also encompasses the design of PID controllers for plants with under damped step response and provides the means for a systematic adjustment of the controller gain in order to meet transient performance specifications. Unlike the Ziegler-Nichols step response method, they provide systematic means to adjust the proportional gain in order to have no overshoot on the closed-loop step response. In addition, since all the development of the methodology relies solely on concepts introduced in a frequency-domain-based control course, the paper has also a didactic contribution.

Wen Tan [7], the author compared the well-known PID tuning rules. Criteria based on disturbance rejection and system robustness are proposed to assess the performance of PID controllers. A simple robustness measure is defined and the integral gains of the PID controllers are shown to be a good measure for disturbance rejection. The integral error is generally accepted as a good measure for system performance. Clearly, if the response is critically damped, IE will be equal to IAE. However, if it is weakly damped, then IE will not be suitable as a performance measure.

K. J. Astrom et al. [8] analyzed the Ziegler-Nichols step response method for PID control. The Ziegler-Nichols step response method is based on the idea of tuning controllers based on simple features of the step response. This paper has revisited tuning of PID controllers based on step response experiments in the spirit of Ziegler and Nichols. Ziegler and Nichols developed their tuning rules by simulating a large number of different processes, and correlating the controller parameters with features of the step response. Process dynamics was characterized by the parameters obtained from the step response. A nice feature of this design method is that it permits a clear trade-off between robustness and performance. The idea is investigated from the point of view of robust loop shaping. The results are insight into the properties of PI and PID control and simple tuning rules that give robust performance for processes with essentially monotone step responses.

Mohammad Ali Nekoui [9], the author presents the optimal design of PID controller based on a particle swarm optimization (PSO) approach for continuous stirred tank reactor (CSTR). The mathematical model of experimental system had been approximate near the operating point for the PSO algorithm to adjust PID parameters for the minimum integral of time multiplied by absolute error (ITAE) condition. This research explains a design of PID controller by using the PSO method to search for optimal parameters converting into the optimal point and the good control response based on the optimal values by the PSO technique.

S.Palanki et al. [10] developed software module to run a simulation via the internet. The software module is developed in MATLAB and simulates a regulation problem in a continuous stirred tank reactor (CSTR) in which a series reaction is occurring. The user has the option to input a wide variety of system parameters, initial conditions, final time, and controller parameters. The effect of changing these values on the overall system dynamics can be studied easily. The development of such modules eliminates space, time, and cost constraints. It was found that this software module was a useful teaching supplement to the traditional classroom lecture. Students were able to study the effect of changing various process parameters as well as controller parameters on the regular output. The interactive distance learning concepts include the use of remote computer access to enhance self-paced learning. The internet provides a real-time link that eliminates space time constraints, and gives access from anywhere at any time. Moreover, due to the multiuser-multitasking nature of computer environments, several students can run the software module at the same time. The development of a virtual laboratory has the potential to deliver experiences which are not accessible to students in the real world. Recent technological advances in computer software are bringing virtual laboratories within the reach of educational and student budgets.

J. Kennedy et al. [11] introduced particle swarm methodology for the optimization of non-linear functions. Particle swarm optimization is an extremely simple algorithm that seems to be effective for optimizing a wide range of functions. We view it as a biologically derived algorithm, occupying the space in nature between evolutionary searches, which occurs on the order of milliseconds. Particle swarm optimization as developed by authors comprises a very simple concept, and paradigms can be implemented in a few lines of computer code. It requires only primitive mathematical operators, and is computationally inexpensive in terms of both memory requirements and speed. Early testing has found the implementation to be effective with several kind of problems. This paper discusses application of the algorithm to the training of artificial neural network weights. Particle swarm optimization has also been demonstrated to perform well on genetic algorithm test functions. The adjustment toward pbest and gbest by the particle swarm optimizer is conceptually similar to the crossover operation utilized by genetic algorithms.

B. Nagaraj et al. [12] compared the different soft computing techniques for PID controller. The methodology and efficiency of the proposed method are compared with that of traditional methods. Determination or tuning of the PID parameters continues to be important as these parameters have a great influence on the stability and performance of the control system. Research work has been carried out to get an optimal PID tuning by using GA, EP, PSO and ACO. The results obtained reflect that use of soft computing based controller improves the performance of process in terms of time domain specifications, set point tracking, and regulatory changes and also provides and optimum stability.

III. CONCLUSIONS

One of the most popular controllers both in the realm of the academic and industrial application is PID. Easy implementation of PID controller, made it more popular in system control applications. It tries to correct the error between the measured outputs and desired outputs of the process in order to improve the transient and steady state responses as much as possible. In one hand, PID controller appear to have an acceptable performance in the most of systems, but sometimes there are functional changes in system parameters that need an adaptive based method to achieve more accurate response. Several researches are available that combined the adaptive approaches on PID controller to increase its performance with respect to the system variations

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