MODELLING OF TEMPERATURE CONTROL PROCESS USING GENETIC ALGORITHM

Abstract:

PID(propotional-integral derivative)controller is the most widely used in industrial controllers .Here the tuning of PID controller is done using Ziegler-Nichols II method.For the multi variable process,non-linear process and the chemical industries IMC(Internal model) controller is used.The need for improved performance of the has led to the development of robust and optimal contollers.Genetic algorithms(GA) is an evaulationary algorithm that is proposed for use in this respect.Genetic algorithms is an optimization technique for searching very large spaces that model the roles of the genetic materials in living organisms.

The modelling of the physical system are presented using different control tuning techniques and applied for the regulation of the temperature process.The structure of the mpdels has been implanting using MATLAB Simulink.Determination or tuning of the propotional integral (PI) parameters continues to be important as these parameters have a great influene on the stability and performance of the control system.The efficiency of the proposed method are compared with of the internal model(IMC) and proves to be better in the performance index.

Keywords: IMC (Internal Model Control),GA(GeneticAlgorithms), MATLAB Simulink

1. Introduction:

In any of the process control and automation industries, controller designing and the automatic control is the most important part. The aim of this paper presents the analysis of temperature process control and robust controller. Control or maintaining the temperature at a desired state is an important and common task in all process industries. Traditional controllers are easy to understand and implement. PID controllers are applicable to many control problems, but they can perform poorly in some control applications. This conventional techniques were unable to give satisfactory results for thapplication output. IMC is a practical control design strategy that is employed in many advanced control system design packages.

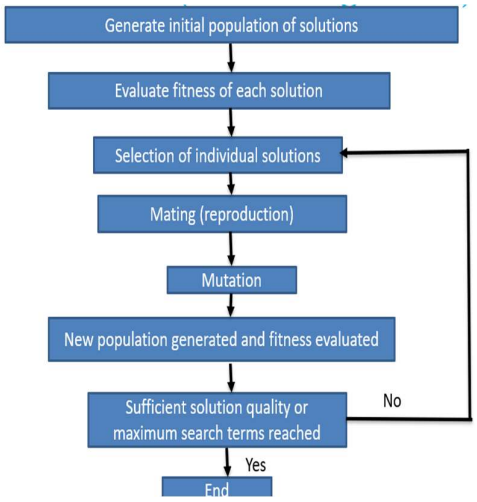
Among the other tuning methods, IMC PID controllers tuning methods has gained widespread acceptance in the process industries because of its easy in design and simple in understand, robustness and fast in real time applications. We have discussed in detail about the development of the mathematical model for the temperature process control. The controllers tuning results of conventional techniques are discussed in deals with the explanation of the optimization techniques Genetic Algorithm and its implementation. The controllers comparative studies and results .The conclusions arrived, based on the results.

2.Methodology:

Genetic Algorithms (GA) is an evolutionary algorithm that is proposed for use in this respect. Genetic algorithms (GA) is an optimization technique for searching very large spaces that Models the role of the genetic material in living organisms.. The modeling of the physical system are presented using different control tuning techniques and applied for the regulation of the temperature process. The structure of the models has been implanting using MATLAB simulink. Determination or tuning of the Proportional-Integral (PI) parameters continues to be important as these parameters have a great influence on the stability and performance of the control system. The efficiency of proposed method are compared with that of Internal Model Control (IMC) and proves to be better performance.

In this we have discussed in detail about the development of the mathematical model for the temperature process control. The controllers tuning results of conventional techniques are discussed . the explanation of the optimization techniques Genetic Algorithm and its implementation. The controllers comparative studies and results are given. The conclusions arrived, based on the results is given .

3.Flow chart:



In Genetic algorithm is a powerful search algorithm that performs an exploration of the search space that evolves in analogy to the evolution in nature. They use probabilistic transition rules instead of deterministic rules, and handle a population of potential solutions known as individuals or chromosomes that evolves iteratively. Iteration of the algorithm is termed as generation. The evolution of solutions is simulated through a fitness function and genetic operators such as reproduction, crossover and mutation. The fittest individual will survive generation after generation, while also reproducing and generating offspring's that might be stronger. At the same time, the weakest individuals disappear from each generation. A genetic algorithm is typically initialized with a random population consisting of between 20 100 individuals. This A genetic algorithm is typically initialized with a random population consisting of between 20 100 individuals. This population (mating pool) is usually represented by a real-valued number or a binary string called a chromosome. How well an individual performs a task is measured and assessed by the objective function. The objective function assigns each individual a corresponding number called its fitness. The fitness of each chromosome is assessed and a survival of the fittest strategy is applied. In this project, the magnitude of the error will be used to assess the fitness of each chromosome. There are three main operators for a genetic algorithm; these are known as reproduction, crossover and mutation.

4.IMPLEMENTATION OF GA:

The optimal values of the conventional PI controller parameters Kp and Ki, is found using GA. All possible sets of controller parameter values are chromosomes whose values are adjusted so as to minimize the objective function, which in this case is the error criterion, which is discussed in detail. For the PI controller design, it is ensured the controller settings estimated results in a stable closed loop system.

Initialization of Parameters:

To start up with GA, certain parameters need to be defined. It includes the population size, bit length of chromosome, number of iterations, selection, crossover and mutation types etc. Selection of these parameters decides to a great extent the ability of designed controller [13-14]. The range of the tuning parameters is considered in the range of 0-10. Initializing the values of the parameters for this paper is as follows: Population size – 100 Bit length of the considered chromosome – 6 Number of Generations – 100 Selection method – 'Maximum Geometric selection' Crossover type – 'Single point crossover' Crossover probability – 0.8 Mutation type –'Uniform mutation' Mutation probability – 0.05

5. Applications:

- Heat Treat/Oven. It Temperature controllers are used in overs and in heat treating applications within furnaces, kilns,boilers,and heat exchangers.
- Packaging.....
- Plastics.....
- Healthcare.....

6.RESULT:

In this section the tuned values through the traditional as well as the proposed techniques are analyzed for their responses point of 15 cm. A tabulation of the time domain specifications comparison and the performance index

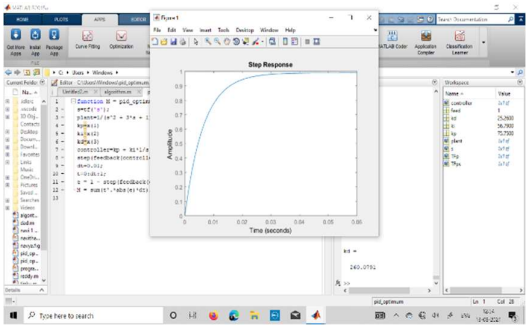


Figure:Output

Simulated Response of the Temperature Process:

It is clear from the responses that the GA based controller has the advantage of a better closed loop time constant, which enables the controller to act faster with a balanced overshoot and settling time. The response of IMC controller is more sluggish than the GA based controller. The time domain specification comparison is done for the IMC and GA based controllers for the responses obtained, is tabulated and given in Table 1. For the proposed model the comparison of performance index were done and are listed.

7. Conclusion:

The various results presented above prove the better in their performances of the GA tuned PID settings than the PID controller Z-N II and IMC controller tuned ones. The simulation responses for the process models validated reflect the effectiveness of the GA based controller in terms of time domain specifications. The performance index under the various error

criterions for the proposed controller is always less than the PID Z-N II and IMC tuned controller. Above all the simulated responses confirms the validity of the proposed GA based tuning for

the temperature process. The closed-loop responses for Ziegler-Nichols II tuning for an ideal PID controller has offset and the responses are quite oscillatory. This is one of the major disadvantages to the Z-N II tuning method. If the process conditions changes, then the control system may become oscillatory and unstable. In order to overcome these disadvantages advanced controllers like IMC control and GA controller are implemented. The main advantage of the IMC controller is, it provides a transparent framework for control system design and tuning . Thus, IMC is able to compensate for disturbances and model uncertainty. The temperature control system is studied and the mathematical model of the first-order system with time delay (FOPDT) system is developed. Conventional PID and IMC controller is implemented for the system and the results are discussed . The performance of GA controller is found to be good which ignores the presence of any Non linearity in the system .

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