PAPER INFORMATION

Title: ONLINE TUNING OF PID CONTROLLER FOR TIME-VARIANT SYSTEMS USING GENETIC ALGORITHM.

This Paper comes under the following domains:

AI Methodology: Evolutionary Computation

AI Application : Control and Automation

Authors:

1. Mr.N.Selvaganesan M.E, Research Scholar, Department of Instrumentation, MIT, Anna University, India.
2. Mr. Prabhu Jude Rajendran B.Tech, Software Engineer, Infosys Technologies Ltd, India
3. Dr. S.Renganathan, Vice-Chancellor, Bharath Institute of Higher Education and Research, India.

DETAILS FOR CORRESPONDENCE:

Name of the Corresponding Author: Mr. Prabhu Jude Rajendran

Postal Address 407, Sai Niketan Apartments,
12, Lock Street,
Kotturpuram,
Chennai,
Tamil Nadu- 600 085.
INDIA.

Electronic mail prabhu_rajendran@infosys.com
prabhu_jude@yahoo.com

Phone 91-44-24471465
91-98413 82010

Fax 91-44-28492576

ONLINE TUNING OF PID CONTROLLER FOR TIME-VARIANT SYSTEMS USING GENETIC ALGORITHM.

Mr.N.Selvaganesan, Mr.Prabhu Jude Rajendran, Dr.S.Renganathan

EXTENDED ABSTRACT

PID controllers are one of the most widely used controllers in many industrial sectors. The popularity of the PID controllers can be attributed partly to their robust nature and partly to the simplicity and flexibility in their design. However, in order to derive a good performance from the PID controllers, it is necessary to tune the controller parameters Kp, Ti, Td to the appropriate values. Researchers, worldwide, have come out with numerous methods of tuning the parameters to derive an optimum performance from PID controllers. These controller settings are dependent on the system parameters, and hence the controller requires to be tuned whenever there is a change in the system parameters. This paper attempts to develop a software to tune the PID parameters for processes with varying system parameters using Genetic Algorithm (GA). The performance of GA based tuning for adaptive controller is compared with the Zeigler Nichols method of tuning for similar time varying systems.

Fig 1 shows the generalized block diagram to represent the methodology that is used for tuning the controller designed for systems with time varying parameters. It is required to identify the parameters of the system before tuning the controller. There are many methods available in the literature that can take care of the identification of system parameters. RLS (Recursive Least Squares) is one of the very famous system identification techniques that can be used for this purpose. The objective is to develop an online tuner for an adaptive PID controller for process with varying system parameters.

Fig 2 shows the flowchart of the genetic algorithm implemented in the program. The problem of finding the optimum parameters can be deduced as the problem of finding the parameters of the controller in order to minimize the ISE (Integral Square Error). The reciprocal of the ISE (optimization function in this case) is used as the fitness function of the problem. We followed binary encoding method in our program where the control variables are coded as finite-length string of 0s and 1s.The three important operators of SGA (Simple Genetic Algorithm) namely reproduction, crossover, mutation have been implemented in our program (developed using C programming language) to derive the optimum tuning parameters for the PID controller.

In order to develop an online tuner, the program is designed to get the varying parameters of the system (assumed to be obtained using RLS or other well established system identification algorithm) during the runtime. The individuals of the population producing the offspring are chosen using the Roulette wheel selection method. In order to simplify the GA implementation we have used single point crossover and bit-by-bit binary mutation in our program. Following the suggestion of De Jong [1] we have adopted the following parameters for our simulations: Pmutation=0.0333, Pcross=0.6 and Population size =30.

The superiority of the GA based online controller was verified by comparing the performance of the controller with that of an online tuned controller that uses Z-N setting. We have used typical 2nd and 3rd order processes with time varying parameters for our simulation purposes. The performance indices and the simulation graphs clearly indicate that the designed software is able to optimize the parameters using GA to enhance the performance of the adaptive PID controller .The tuner (designed software) is also tested for performance in typical cases of set-point variations (multi-step inputs) and load disturbances.

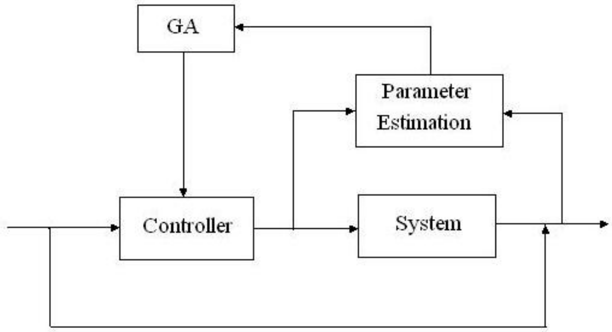


FIG 1: BLOCK DIAGRAM OF THE CONTROL SYSTEM USING A GENETIC ALGORTIHM TUNER

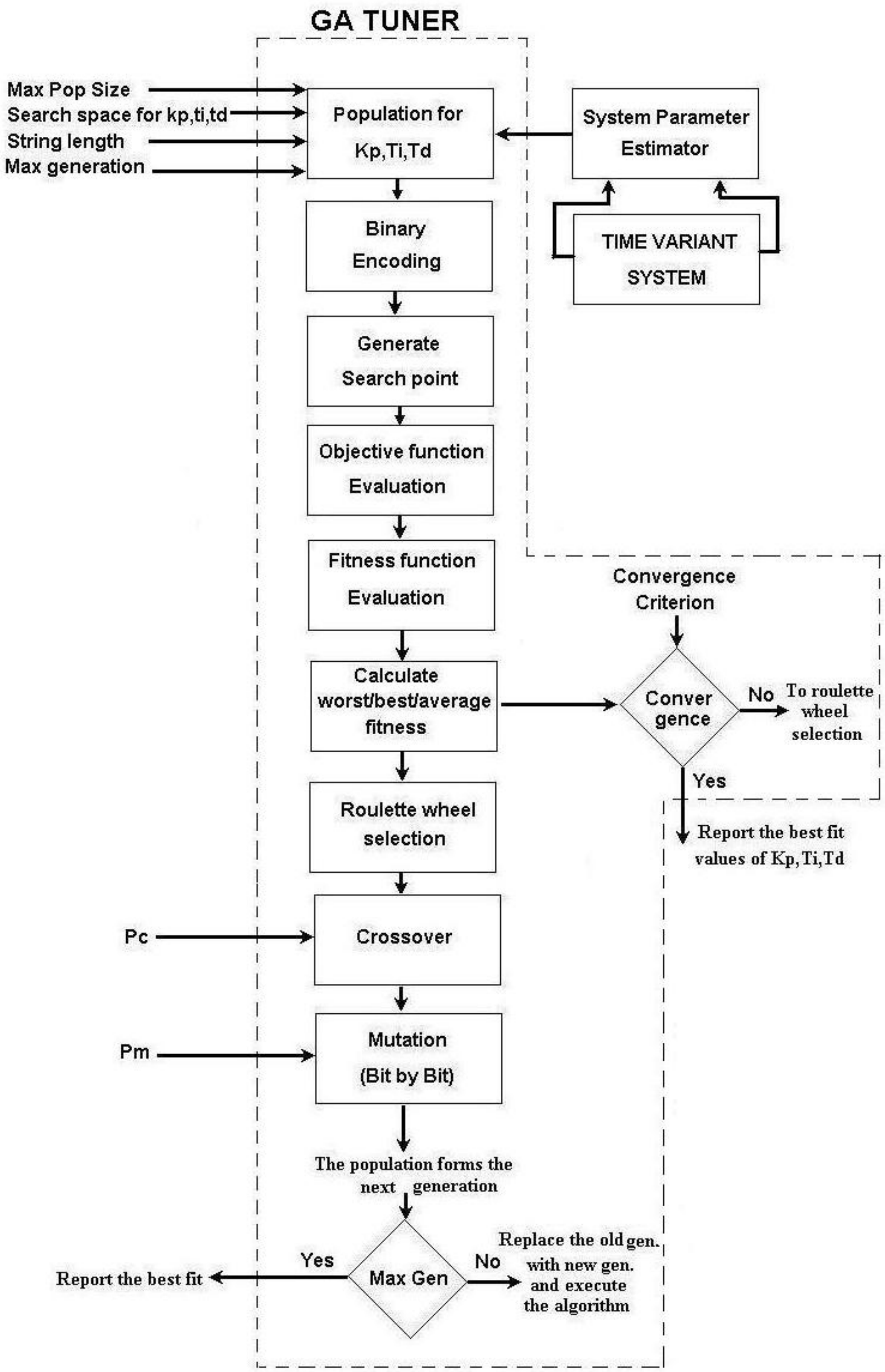


FIG 2: FLOW CHART TO SHOW THE LOGICAL SEQUENCE FOLLOWED IN THE SGA (SIMPLE GENETIC ALGORITHM) FOR TUNING THE ADAPTIVE PID CONTROLLER.

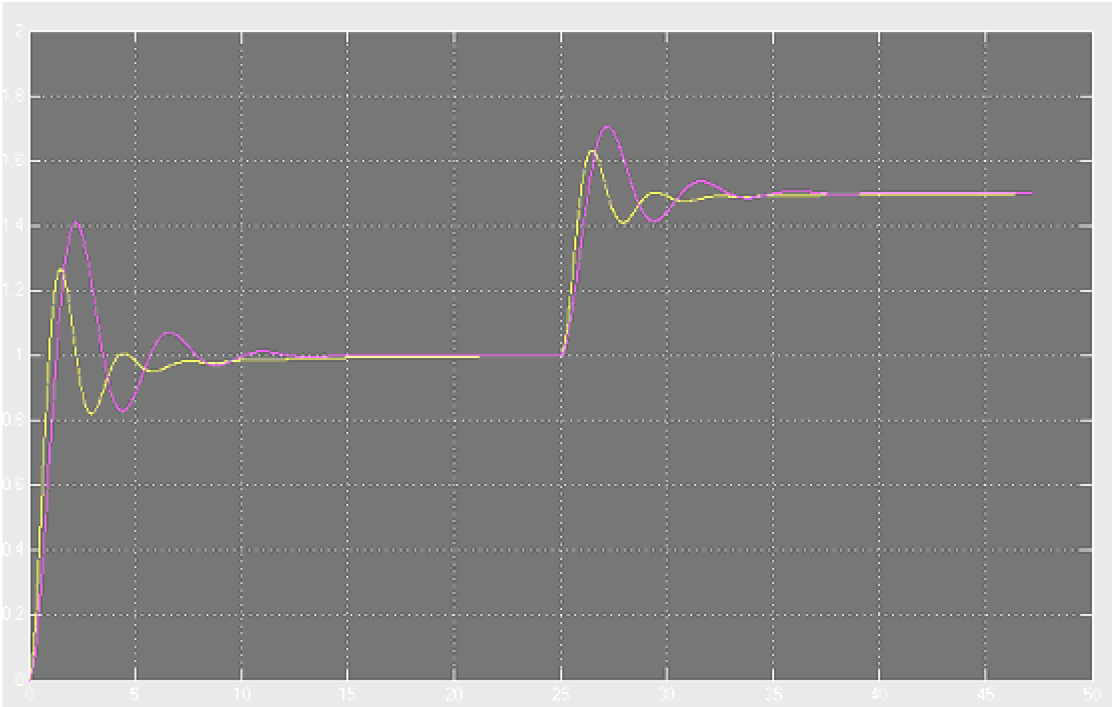
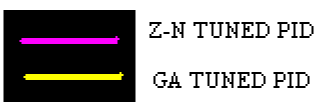


FIG 3: PERFORMANCE OF THE PID CONTROLLER FOR MULTI-STEP INPUT TO A THIRD ORDER SYSTEM $1/(S^3+3S^2+3S+1)$ **



PERFORMANCE INDEX	***Z-N TUNED PID CONTROLLER***	***GA TUNED PID CONTROLLER***
ISE	3.62	2.70
IAE	5.158	4.86

FIG 4: COMPARISON OF PERFORMANCE INDICES –ISE (Integral Square Error) AND IAE (Integral Absolute Error)

** *SINCE THIS IS AN ONGOING RESEARCH WE HAVE RESERVED MORE SYSTEM-SPECIFIC PERFORMANCE RESULTS IN ADAPTIVE TUNING FOR OUR FINAL MANUSCRIPT.*

PRINCIPAL REFERENCES:

1. David E. Goldberg, “Genetic Algorithm in Search, Optimization and Machine Learning”, (1989) Addison Wesley Publications.

2. Davis L., & Ritter F., “Schedule Optimization with probabilistic search”, (1987) Proceedings of the 3rd IEEE Conference on Artificial Intelligence Applications.

3. Katsuhiko Ogata, “Modern Control Engineering”,(1995) Prentice Hill Publications.

4. Mitsuo Gen, Runwei Cheng, “Genetic Algorithms and Engineering Design”, (1997), John Willey and Sons.

5. Jerry M. Mendal, “Discrete Technique of Parameter Estimation-The equation error formulae”,(1973), New York Maral Dekker Inc.,