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Analysis and Evaluation of the Efficiency of Laser Temperature Control System

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Analysis and evaluation of the efficiency of laser temperature control system

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Abstract— This article describes a method for temperature controlling of semiconductor laser. There are various wavelength of temperature in semiconductor laser. The paper provides a comparative analysis of the effectiveness of control using PID and FLC controllers. The PID controller cannot exactly control in extensive rate of accuracy temperature. Therefore, we used the FLC regulator to be improved the accuracy temperature with extensive rate for laser temperature regulator. A comparative analysis describes that the effectiveness of the FLC regulator is better than that of other regulators.

Keywords—PID controller, FLC controller, Laser temperature control system

I. Introduction

Semiconductor lasers are distinguished by high efficiency among optical quantum generators. One of the key characteristics is that these devices are very small, with characteristic linear dimensions of the order of several hundred microns per side. These lasers have the type of solid-state, which, unlike ordinary solid-state lasers, are made of semiconductor materials. Pumping semiconductor lasers is carried out directly from the electric current, which is transmitted through the device .In this article we have been tested various kind of temperature controller system, such as PID regulator, Fuzzy logic regulator and Fuzzy-PID regulator. We have been used control methods which are Fuzzy logic control and Fuzzy-PID control because of it is not enough to obtain satisfactory control results when just using conventional PID controller. The object of laser is a type of first-order control system for control purposes. The feedback sensor of temperature is $\frac{1}{ts+1}$ in transfer function, where t is the time of the monitored object, t1 is the time of temperature sensor, where t = 2, t_1 = 0.5 is determined by lasers temperature sensor.

II. Model of controller

(i)Proportional-integral-derivative controller (PID)

PID controller is one of the famous types of regulators. Currently, about 80-90% of regulators have been used in the PID controlling. These reasons for high performance and effective of ability, simple of construction, easy to use and low cost. Among PID regulators, 64% are single-loop regulators and 36% are multi-loop ones. Controllers with feedback cover 85% of all applications, controllers with direct communication - 6%, and controllers connected in cascade - 9%.

A proportional- integral- derivative is a feedback loop system and often used in machine control systems and can be modeling various kinds of applications, when requiring modulated. A PID controller can be control error value to be closely reached desire set point variable in controlling process from measured variable to base on proportional, integral and derivative.

(ii)Fuzzy logic controller

Fuzzy regulators are formed with two input data, an error and an error change, and one output data. The Fuzzy Mamdani system designed on function of linear for both inputs and outputs data. In the Fuzzy Logic regulator, the input variables of data can be adjustment of value for desired output data. For input data and output data have been used the type of triangular (membership function). Each data has 7 triangular (membership functions). That, only 49 rules was created.

This 49 rules can be structure negative feedback control under all conditions for maintain stability. Linguistic data of fuzzy rules of 49for 7*7 two inputs are shown in Table 1.In fig. (1), (2) and (3) shows the triangular (membership functions) of varying data developed in the FIS editor in the MATLAB package.

The Fuzzy Logic regulator is purpose to have two input data and one output data control variable for simulation temperature control of the semiconductor laser. These of two data are the blunder and change in mistake. It demonstrates the fundamental piece chart of Fuzzy rationale controller with data and yield variables. These formular are loading by Mamdani consequently, that is why as Mamdani's FIS. Data values for each input data settle with the fuzzification convert crisp input of information from the sensor. The data base on action the outputs of each fuzzy-data (IF-THEN) rules performs on consequently logic makes how to fuzzy logic loading. These two components are combining into the inference block. Crispy values within the defuzzification block combine and convert all of the outputs. The fuzzy rules could expresses such as a matrix P, $p=E \times EC\ K\rho * Ki * Kd$ Firstly, "mini" implication method is used to be calculate the matrix *P*. Then aggregation operation of fuzzy sets of inputs and matrix R, where "maxi-mini" aggregation method is used to gain the fuzzy reasonable results of outputs. So the defined of output values are needed for application, finally the results of fuzzy should be defuzzification. In this paper, for defuzzification was used the "Centroid" method, the gain of accurate values *kp*, *ki* and *kd* and then, they will sent to PID controller to control the system.

The error data is the difference between the desired point and really output result temperature of laser. Seven linguistic words are formed for the fuzzy sets i.e. nero-big, nero-medium, nero-small, zero, peso-small, peso-medium, peso-big which are defined nb, nm, ns, ze, ps, pm, pb respectively. The fuzzy sets, then defined by the triangular (membership functions).

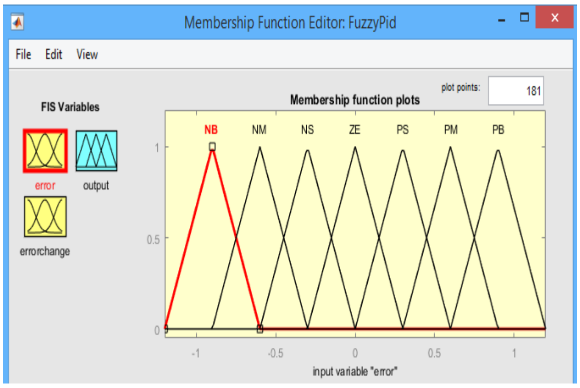

Fig. 1.Membership function of error

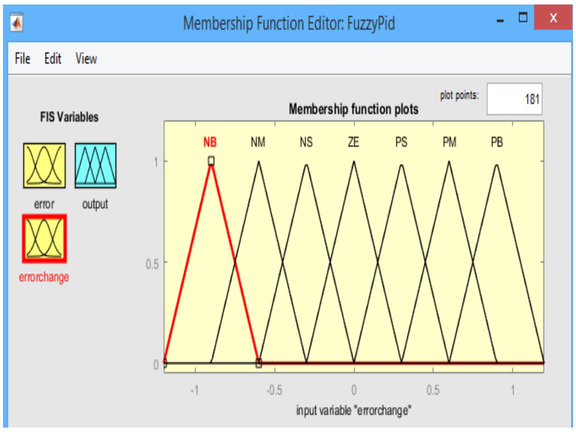

Fig. 2.Membership function of error change

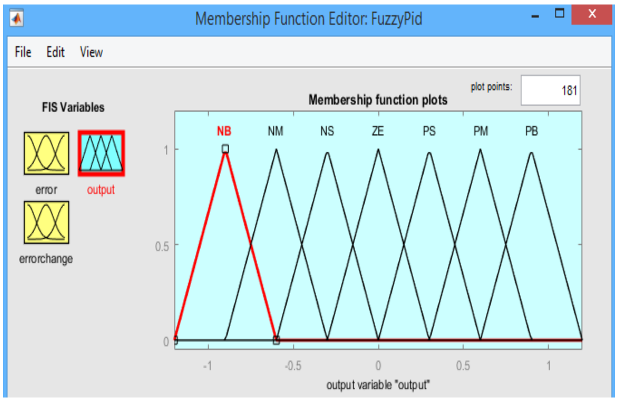

Fig. 3.Membership function of output

Triangular (membership function) on the base 7*7 rules. We use a group of seven functions of triangular membership for input / output variables. The table includes 49 rules for 7 * 7 two inputs.

Table 1

The base of fuzzy rules of 49 rules for 7 * 7 two inputs

e/ed	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	ZE
NM	NB	NB	NB	NM	NS	ZE	PS
NS	NB	NB	NM	NS	ZE	PS	PM
ZE	MB	NM	NS	ZE	PS	PS	PB
PS	NM	NS	ZE	PS	PM	PB	PB
PM	NS	ZE	PS	PM	PB	PB	PB
PB	ZE	PS	PM	PB	PB	PB	PB

III. DESIGN OF PROGECT

The format of this project is to enhance exactly temperature control of semiconductor laser in Fuzzy Logic Controller (FLC) and conventional PID controller by using MATLAB/Simulink. The results of simulation FLC and PID regulator is express and discuss in simulation results section 4 and 5 .

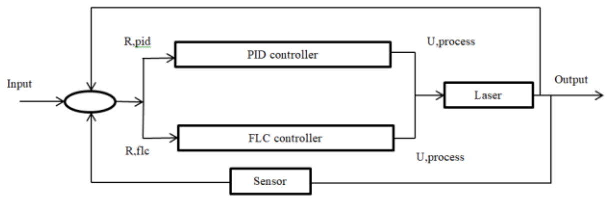

Fig. 4.Block diagram of temperature control of semiconductor laser

Fig 4 consists of (6) various block. We can know actually outputs in laser temperature control processing by sensor. If we will be continued error signal between set point and actually output, can reduce by using controller adjustment.

This flow chart shows performance between Fuzzy Logic regulator (FLC) and PID regulator in laser temperature control system. At firstly, we simulated both of PID and FLC controllers with the same variable by using Matlab Simulink. At the end, as results of compare both simulation result, can be known, which controller can better performance in laser processing.

FLOW CHART

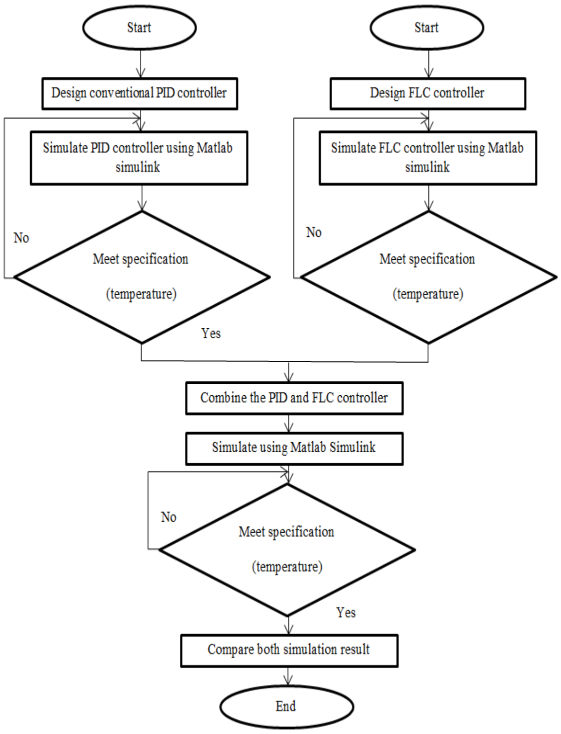

Fig. 5.Flow chart of methodology

IV. Simulation Result

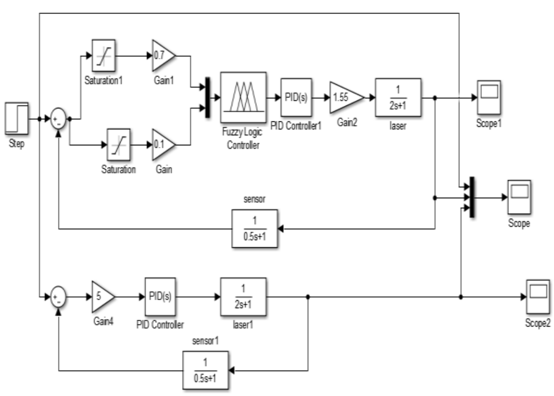

Fig. 6.Simulink control model of PID and Fuzzy-PID

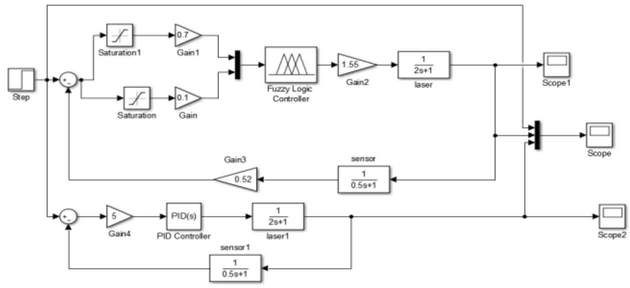

Fig. 7.Simulink control model of PID and Fuzzy

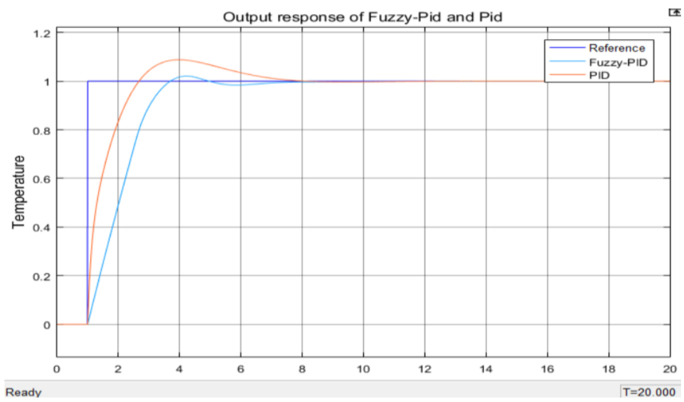

Fig.8.Output result of PID and Fuzzy-PID controller

Figure 8 compares the two controllers, the Fuzzy-PID regulator and the convectional PID regulator. According to the results, it is clearly seen that the Fuzzy-PID regulator is better than performance the convectional PID regulator.

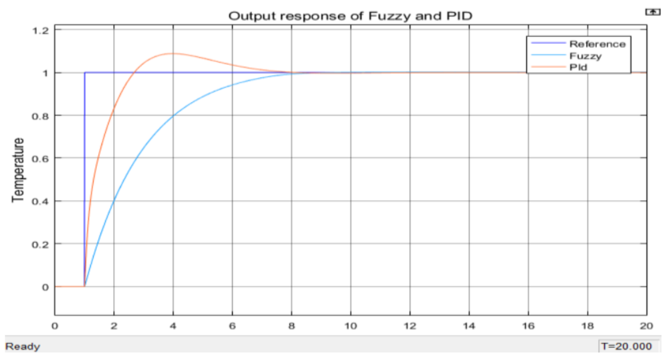

Fig. 9.Output result of Fuzzy and PID regulator

Figure 9 compares the two controllers, the Fuzzy regulator and the convectional PID regulator. The results of simulation show that of all three regulators, which are called the conventional PID regulator, FLC and Fuzzy-PID, the Fuzzy regulator has zero excess, a short settling time, better adaptability and reliability.

V. CONCLUSION

Finally, in this paper presents the comparative results of the temperature control system of a semiconductor laser using conventional PID controller, an FLC controller and an FLC-PID controller. The simulation result shows that FLC regulator has better dynamic performance, stronger adaptive reliability and large inertia than other regulators.

VI. REFERENCES

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