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PID Control with Fuzzy Compensation for Electric Power Generation Unit

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Abstract

Controller that is designed in this paper is form that apply PID controller about Fuzzy algorithm. Fuzzy Controller that using this paper is can speak that compensation style fuzzy controller as form to solidify action of PID controller for plant. This is not form that autotuning the each PID coefficient . We Apply and examined the response character to AGC(Automatic Generation Control) system using designed controller.

I. Introduction

It is fundamental purpose of controller that difference of reference that user wants and output of real system should be small. And, classical control theory expressed this purpose by rise time, maximum overshoot, settling time, stated state error etc. Modern control theory that mark system in state variable ground expresses by error of input and output coming out. And optimal control theory is been studying much field so far to theory that get controller. When width that system parameters change according to environment change are big, can not be so in other environment even if show satisfied action in some environment. Specially, by much change of system parameters, there is case that system becomes unstable. When use of PID controller, output of system is that reach in reference by suitable PID coefficient value adjusting. But, when change reference or change of control target, must adjust coefficient value of PID controller again. On the other hand, fuzzy controller can take response characteristic about system. because it selected human's way of thinking. But, can be very complicated in choice of suitable membership function, rule set etc.. Therefore , In this paper, We are purposeful to minimise happened error making use of compensation style fuzzy controller In front of PID controller. In case of PID controller that have fixed parameter, situation that do not reach in steady state is happened often about load and disturbance. And that have the steady-state error. Therefore, change of control signal is required by parameter change. But, in case make use of such system usually, Various parameter set and its using may not become efficient control process preferably about system in situation that various load changing happens. Therefore, this may have gotten near output in reference if tuned reference of new parameter to system. it is just like user does for compensates error. This paper present techniques to process such method autonomously in system. Using controller that design in this paper, Apply and examined the response characteristic to AGC system.

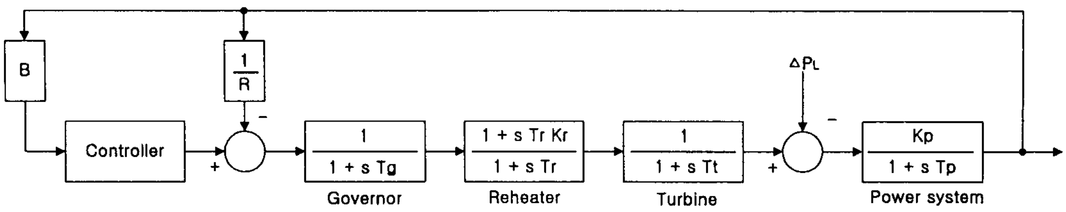


Fig. 1. AGC System

II. AGC system

Figure 1 is show block diagram of AGC system. AGC system is consisted of Governor, Reheater, Turbine, Power system approximately. Show parameter and value of used AGC system in table 1.

Table 1. Parameter of AGC system

Parameter	Value
Governor time constant [T_g]	0.08
Turbine time constant [T_t]	0.3
Reheater time constant [T_r]	10
Power system time constant [T_p]	20
Power system gain [K_p]	120
Spe2.4ed regulation due to governor action [R]	2.4
Reheat coefficient [K_r]	0.5
Frequency bias setting [B]	0.425

III. Design of Controller

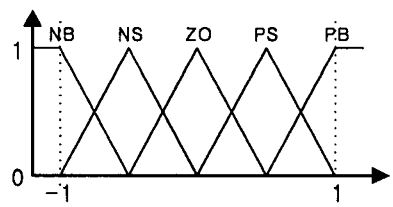
Figure 2 show block diagram of compensation style fuzzy controller that use in this paper. Making use of fuzzy controller in front of PID controller can reduce error. Also, can get fast response characteristic and stable result at change of plant. Equation 1 formulates state that whole system is acted when combine fuzzy controller and PID controller.

$$u(t) = K_p[r(t) + e(t)] + K_i \int e(t)\,dt + K_d \frac{de(t)}{dt} \quad (1)$$

Table 2 and figure 3 display rule table and membership function of fuzzy controller that use in this paper. Inference of fuzzy controller used Mamdani's Max-Min and Defuzzificaiton used Center-of-Gravity Method.

Table 2. Rule Table

ce \ e	NB	NS	ZO	PS	PB
NB	NVB	NB	NM	NS	ZO
NS	NB	NM	NS	ZO	PS
ZO	NM	NS	ZO	PS	PB
PS	NS	ZO	PS	PM	PB
PB	ZO	PS	PM	PB	PVB



(a) e, ce membership functions

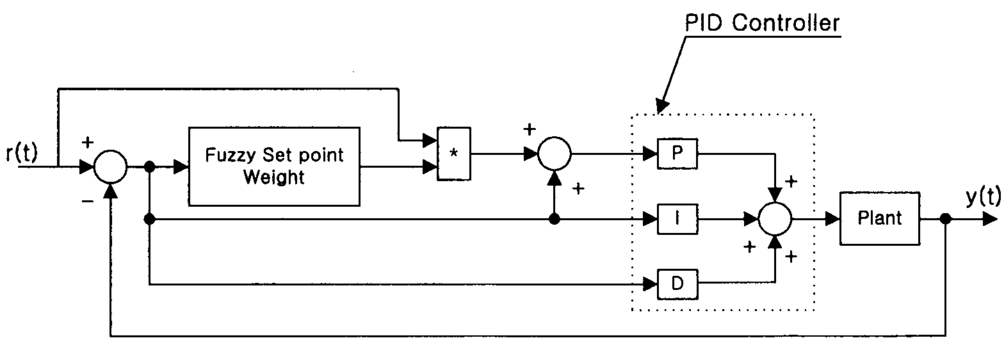
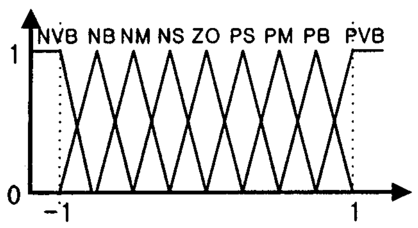


Fig. 2. Block diagram for Compensation Fuzzy controller



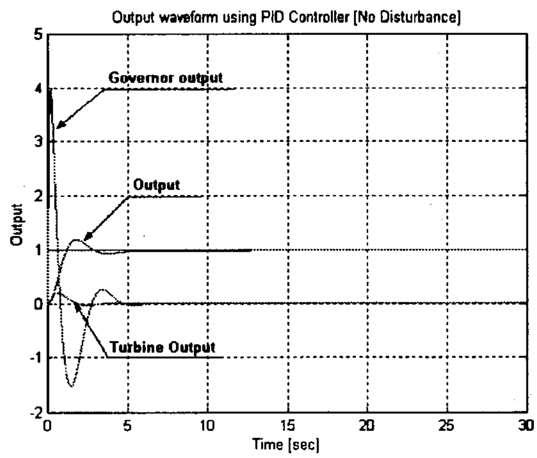
(b) Output membership functions

Fig. 3. Membership functions

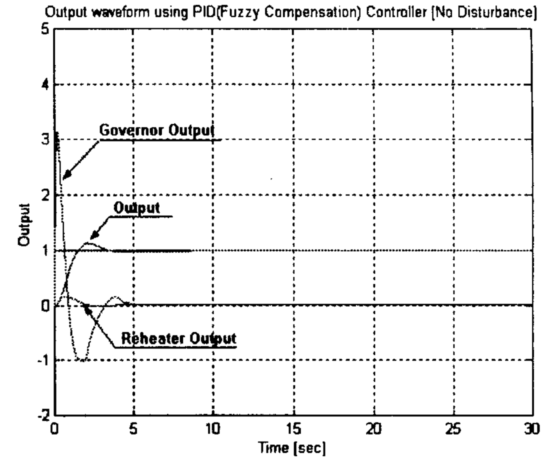
Ⅳ. Simulation

This paper designed compensation style fuzzy controller and apply this to AGC system and examine result through simulation. Figure 4 is simulation result In case supply disturbance to AGC system.

Figure 4 (a) is output waveform in case use the PID controller and Figure 4 (b) is output waveform in case use the compensation style fuzzy controller. As can know through result that fast settling time, less overshoot when make use of compensation style fuzzy controller.



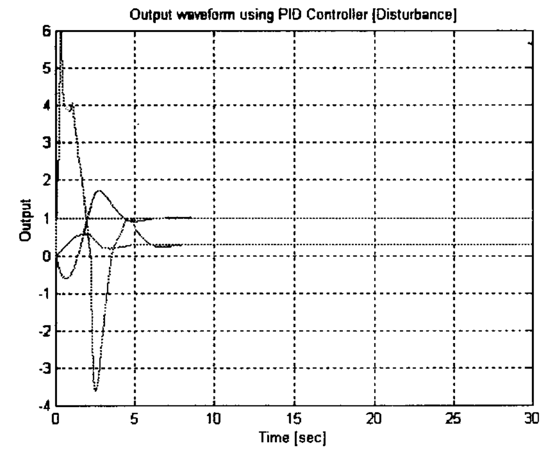
(a) Simulation result using PID controller



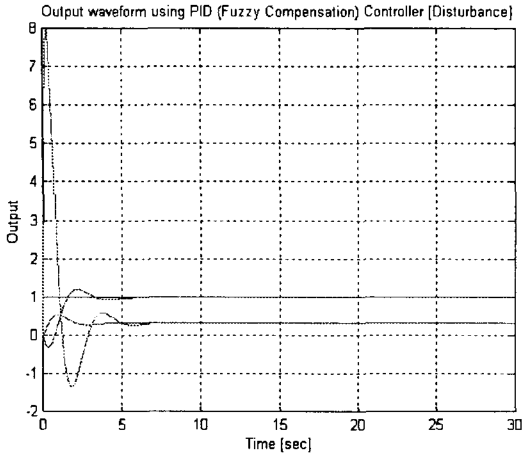
(b) Simulation result using Compensation Fuzzy controller

Fig. 4. Simulation result((No distrubance))

Figure 5 (a) and (b) is response characteristic of each controller when supply disturbance. Compare with figure 4 of case that interrupt disturbance and can know that when make use of PID controller, overshoot happens very greatly. Also, confirmed that settling time of system is prolonged quantity. On the other hand, compare in case interrupt disturbance when make use of compensation style fuzzy controller and confirmed that big difference does not become.



(a) Simulation result using



(b) Simulation result using Compensation Fuzzy controller

Fig. 5. Simulation result((In distrubance))

V. Conclusion

In this paper designed compensation style fuzzy controller in front of PID controller for minimization of response characteristic change that happened supply disturbance. Result that use apply designed controller to AGC system, compare in case make use of PID controller only and confirmed that the response characteristic is very superior. Specially, in case supply disturbance, when make use of PID controller , change of response characteristic is extreme. but, When make use of compensation style fuzzy controller in front of PID controller that designed in this paper, compare with case that is not so with supply disturbance and confirmed that it is no big difference.

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