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Research Article

Fuzzy Control for Food Agricultural Robotics of a Degree

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Abstract: In this study, we have a research of the fuzzy control for food agricultural robotics of a degree. Weeding robots can replace humans weeding activities, since the control system with nonlinear, robustness and a series of complex time-varying characteristics of the traditional PID control of the food agricultural robot end of the operation control effect cannot achieve the desired results, therefore, the design for the traditional use of classical PID control algorithm to control the food agricultural robot end of the operation of a series of drawbacks, combining cutting-edge control theory, fuzzy rule-based adaptive PID control strategy to control the entire system, so as to achieve the desired control effect. Experimental results show that the fuzzy adaptive PID control method for robot end postural control has better adaptability and track-ability.

Keywords: Agent-oriented, food agricultural robotics, fuzzy adaptive PID, fuzzy control, PID

INTRODUCTION

Weeding the grass-cutting robots can replace humans working to alleviate the workload of farmers on the one hand and the intensity of work, on the other hand can be lifted out from the hard work of farmers (Andreev *et al*., 2000; Liu, 2009; Hejun *et al*., 2011). Mathematical model of the object difficult to establish under their control, with traditional PID control technology, it is difficult to meet the requirements of accuracy control system. Fuzzy control is to experience and control people's minds give controller control and decision-making, does not need to build a complete mathematical model, algorithm for designing simple, are an ideal method of nonlinear control. Under the specific parameters of PID control in the control precision is high (Astrom and Hagglund, 1995; Xiao and Ning, 2011; Chen and Lin, 2006). End manipulator position control of robot using fuzzy reasoning method to realize PID parameter on-line self-tuning and the design of parameter fuzzy self-tuning PID controller, MATLAB/SIMULINK emulation. Simulation results show that the significant improvement in the performance of the design method of control system.

In this study, we have a research of the fuzzy control for food agricultural robotics of a degree. Weeding robots can replace humans weeding activities, since the control system with nonlinear, robustness and a series of complex time-varying characteristics of the traditional PID control of the food agricultural robot end of the operation control effect cannot achieve the desired results, therefore, the design for the traditional use of classical PID control algorithm to control the food agricultural robot end of the operation of a series of drawbacks, combining cutting-edge control theory, fuzzy rule-based adaptive PID control strategy to control the entire system, so as to achieve the desired control effect. Experimental results show that the fuzzy adaptive PID control method for robot end postural control has better adaptability and track-ability.

METHODOLOGY

Mathematical model: A total of six robot joints, after three joints as rotational joints, control robot posture control in the same way, so in this discussion end of the operation only a single rotational joint. Articulation drive DC servo motor-driven approach, as the joint shaft angle control amount and in its a potentiometer mounted on the shaft, the angle values into the corresponding voltage value obtained thereby control the robot single joint open loop transfer function:

$$\frac{Y(s)}{X(s)} = \frac{mls^2}{(I + ml^2)s^2 - mgl} \quad (1)$$

According to the characteristics of the motor, selecting appropriate parameters, whereby the single joint robot control open loop transfer function:

$$G(s) = \frac{900}{s^2 + 30s} \quad (2)$$

Adaptive fuzzy PID controller design:

Adaptive fuzzy PID controller design principles: In the conventional PID control, conventional algorithm is:

$$u(k) = K_p e(k) + K_i \sum e(k) + K_d ec(k) \quad (3)$$

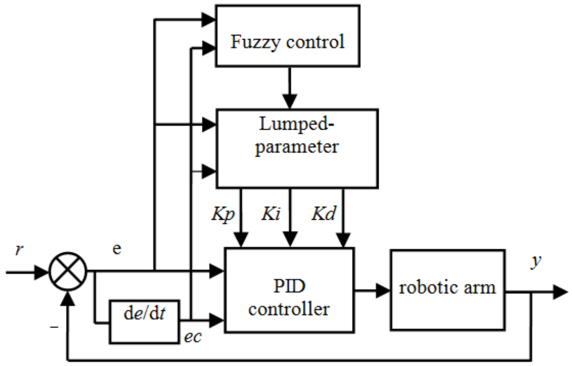

Fig. 1: Structure chart of fuzzy PID controller with self-tuning

Table 1: ΔKp fuzzy control rules

E	ΔKp/EC NB	NM	NS	ZO	PS	PM	PB
NB	PB	PB	PM	PM	PS	ZO	ZO
NM	PB	PB	PM	PS	PS	ZO	NS
NS	PM	PM	PM	PS	ZO	NS	NS
ZO	PM	PM	PS	ZO	NS	NM	NM
PS	PS	PS	ZO	NS	NS	NM	NM
PM	PS	ZO	NS	NM	NM	NM	NB
PB	ZO	ZO	NM	NM	NM	NB	NB

Table 2: ΔKi fuzzy control rules

E	ΔKi/EC NB	NM	NS	ZO	PS	PM	PB
NB	NB	NB	NM	NM	NS	ZO	ZO
NM	NB	NB	NM	NS	NS	ZO	ZO
NS	NB	NM	NS	NS	ZO	PS	PS
ZO	NM	NM	NS	ZO	PS	PM	PM
PS	NM	NS	ZO	PS	PS	PM	PB
PM	ZO	ZO	PS	PS	PM	PB	PB
PB	ZO	ZO	PS	PM	PM	PB	BP

Among them:

$$\sum e(k) = e(k) + e(k-1),$$

Table 3: ΔKd fuzzy control rules

E	ΔKd/EC NB	NM	NS	ZO	PS	PM	PB
NB	PS	NS	NB	NB	NB	NM	PS
NM	PS	NS	NB	NM	NM	NS	ZO
NS	ZO	NS	NM	NM	NS	NS	ZO
ZO	ZO	NS	NS	NS	NS	NS	ZO
PS	ZO	ZO	ZO	ZO	ZO	ZO	ZO
PM	PB	PS	PS	PS	PS	PS	PB
PB	PB	PM	PM	PM	PS	PS	PB

$$ec(k) = e(k) - e(k-1)(k \in N)$$

In this design, EC. Error E and error rate of the input of controller, the adaptive fuzzy PID controller can meet the different time of E and EC self-tuning requirements for PID parameters. In this design, the use of fuzzy control rules, on-line modification to the PID parameter, the control principle diagram as shown in Fig. 1.

Determine the input variable membership function: In this design, the controller uses the two into the three forms. The input EC of deviation E and deviation change rate of linguistic variables, output variables KP, Ki, kd. The language input and output range is seven, respectively, "Negative Big (NB)", "Negative (NM)", "Negative Small (NS)", "Zero (ZO)", "is Small (PS)", "the Median (PM)", "Zhengda (PB)". Among them, the domain of input variables is {6}, -6, domain of output variables are: KP domain is {-0.3, 0.3}, Ki domain is {-0.06 0.06}, KD, domain theory for {-3, -3}.

Design of the control rules: Tuning PID parameters must be taken into account at different times within the three parameters of the role and relationship between each other. According to the parameters KP, KI, KD of the system output characteristics of the case, in different circumstances and e, ec:

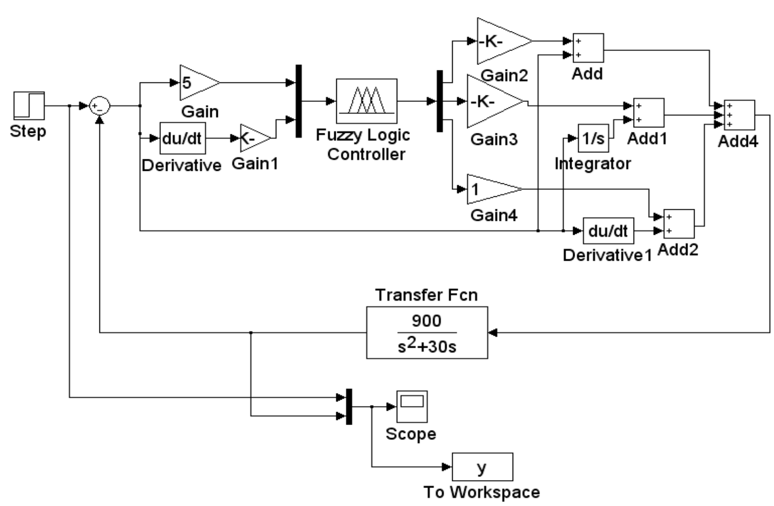

Fig. 2: Fuzzy/PID control system

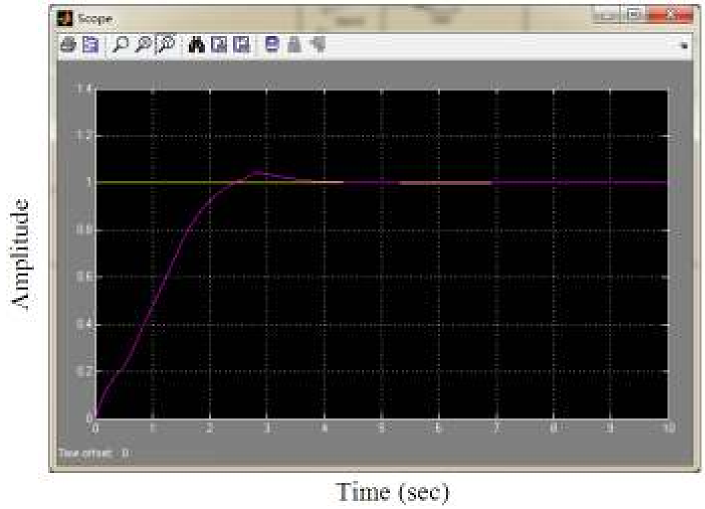

Fig. 3: Step response agricultural robotics of a degree system

If: $kp = kp' + \Delta kp$, $ki = ki' + \Delta ki$, $ki = ki' + \Delta ki$
then: $kp' = 10.5$, $ki' = 0.0001$, $kd' = 10.5$

The design of the control rules as shown in Table 1 to 3.

System simulation model: The control system design, the main control is a single rotation of the robot joint control. As is the shaft angle control amount and the rotation angle value of the sensor into a corresponding voltage value of the transfer function is G (s) = 900/ (s^2 + 30s), the quantization factor deviation e is 5, the deviation change rate quantization factor 1, PID controller the initial scale value of 10.5, the integral value is 0.0001, the differential value of 1. The design of the simulation model is shown in Fig. 2.

SIMULATION RESULTS

Select the basic parameters: e and ec quantify factors were 5, 1; PID controller initial proportional, integral and differential parameters are 10.5, 0.0001, 1.0, with 5% error limits, tracking unit step signal, want to adjust the time 0.054 sec and the corresponding response curve shown in Fig. 3 and calculate the system's performance indicators are as shown in Fig. 3.

CONCLUSION

From the simulation results, the self-tuning fuzzy PID control, the robot end of the operation has a good dynamic performance, rise time, overshoot is small, stable small error. Than the traditional PID control is better.

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