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Biogas engine start controller PID parameter setting

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Abstract. In today's electrical age, error-prevention control and automatic safety device of biogas engine system is playing an important role in modernized production and life. Based on the conclusion of fuzzy-control algorithm, after making up bugs in the above DC speed regulating device and combining error-prevention adjuster and fuzzy control, the compound control scheme (fuzzy) for power error-prevention (namely, the controller scheme for error-prevention control and automatic safety device of electric system which is got from design) is obtained; this scheme can make it meet requirements for speed stabilization and high precision and be able to not suffer from the influence of large fluctuation of load, nonlinear or model parameters.

1. Introduction

The most commonly used device for converting biogas into electric energy which is then transformed into electromechanical energy is error-prevention control and automatic safety device of electric system in substation which is widely used in daily life and economic field. This device can be seen everywhere in fields like agriculture field, aviation field, transportation field, medical field, defense field, and business field, which provides convenience for various fields and daily life. According to investigation and survey, electric system is the supply source of most power resources. Besides, the annual consumption of electric energy of this device accounts for 60% in the nation. It is obvious that this device plays a quite important role in our daily life at present and it is tightly connected with us. In electrical period, this device realizes speed control through simulation method; generally, the simple control of this automatic safety device is used. And this so-called simple control is actually the device for starting and braking automatic safety device which also contains sequence control as well as positive and reverse rotation control. The above control can be realized through relay, switch element, and programmable logic controller these three modules actually. What is opposite to simple control is complex control which mainly controls rotation speed, torque, electric current, rotation angle, voltage, power, and others [1]. Based on the conclusion of fuzzy-control algorithm, after making up bugs in the above DC speed regulating device and combining error-prevention adjuster and fuzzy control, the compound control scheme (fuzzy) for power error-prevention (namely, the controller scheme for error-prevention control and automatic safety device of electric system which is got from design) is obtained; this scheme can make it meet requirements for speed stabilization and high precision and be able to not suffer from the influence of large fluctuation of load, nonlinear or model parameters. At the same time, problems exist in mechanical error-prevention locking, power error-prevention locking, and microcomputer error-prevention locking these three error-prevention systems are summarized; then after absorbing advantages in each error-prevention system, a brand new error-prevention control and automatic safety device for electric system of biogas engine is designed and realized.

2. Analysis and design of software model for power error-prevention

2.1. Software model for power error-prevention

Fuzzy control for biogas engine is one kind of nonlinear control; its control rules are based on human experience; it has good robustness and overshoot suppression ability in controlling nonlinear

objects like switching power supply. Continuous PID algorithm is a kind of fuzzy control algorithm; according to continuous PID algorithm principles, by aiming at actual demands of power error-prevention system, after abstracting from functions of error-prevention control and automatic safety device of electric system, the mathematical model for continuous PID control system is obtained which is shown in the following Fig.1. From this mathematical model, we can see that continuous PID algorithm actually belongs to closed-loop control. Therefore, in realization process of Xiai power error-prevention, closed-loop control is realized for hardware and feedback is implemented at the same time. The most typical ones include control of motor speed; therefore, sensor for rotation speed measurement is necessary; meanwhile, information can be fed back to control line.

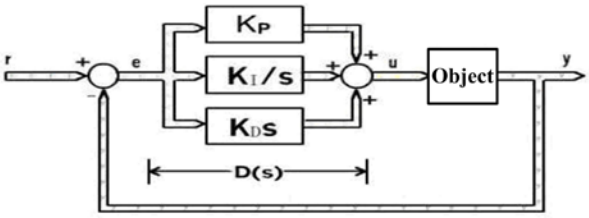

Fig.1 Continuous PID Control System

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Definition of fuzzy PID self-adjusting, power error-prevention control system: according to fuzzy logical inference based on fuzzy rules, obtain power error-prevention data and adjust at the same time. Inference conclusion is corresponding to data under different conditions. Control system constitution is shown in Fig.2.

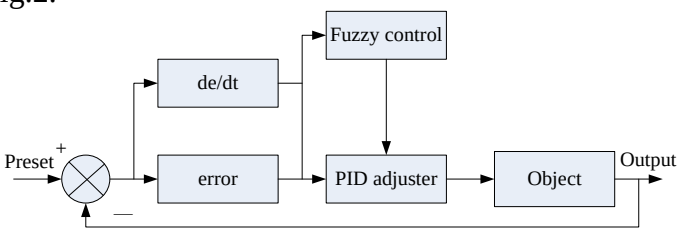

Fig.2 Structure Figure for Parameter Control System of Fuzzy Self-tuning Power Error-prevention

2.2. Design process for DC speed regulating, fuzzy self-tuning power error-prevention parameter controller

The confirmation of input and output data in biogas engine system can be seen from explanatory drawing of fuzzy electric system; correction data structure is a fuzzy system; and data inputted in it are absolute value ｜E｜ of rotation speed error of error-prevention control and automatic safety device in electric system and absolute error change rate ｜EC｜ of rotation speed of error-prevention control and automatic safety device in electric system; outputted data include KP, KI, KD.

Value range of relevant data and their definition in range; in case the range of relevant data in fuzzy system is as follows:

｜E｜: X={0; 1; 2}

｜EC｜: Y={0; 1; 2}

Take “maximum, middle, and minimum” values respectively from range of inputted data ｜E｜ and ｜EC｜, and the membership function curve shown in the figure will be obtained.

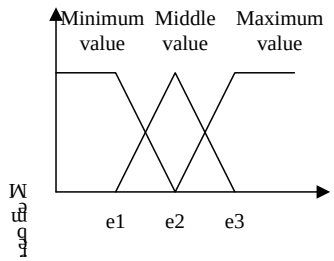

Fig.3 Membership Function of Linguistic Variable Error │E│

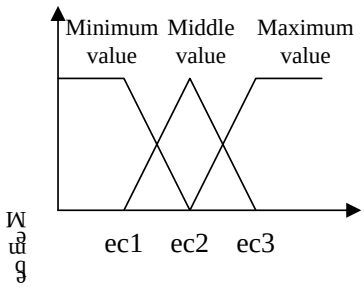

Fig.4 Membership Function of Change Rate │EC│ of Linguistic Variable Error

3. Realization for software of power error-prevention system

The complete hardware composition of speed regulating system is displayed; it includes isolation protection circuit, motor control module, motor drive module, serial communication circuit, and overeurrent protection circuit. The following is detailed introduction of circuit constitution and functions of each module.

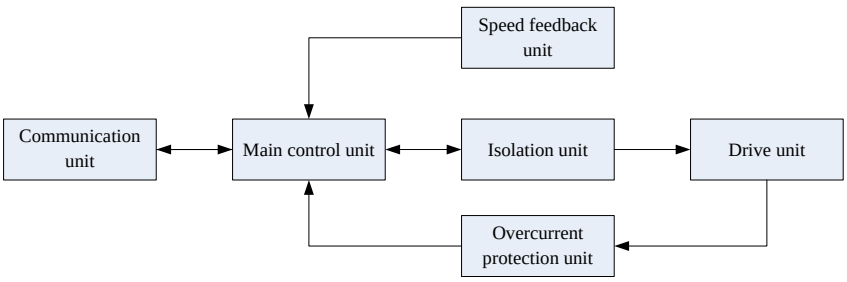

Fig. 5 Figure of System Hardware Composition

Load an incremental photoelectric coded disk to output shaft of error-prevention control and automatic safety device in electric system of biogas engine to be used for speed sensor; directly connect its output ends with A, B, C input ends of LM629 to form feedback loop. The photoelectric pulser adopted in this system is homemade GMC-1200 which has nominal voltage of about 5V. The following figure shows its signal output waveform:

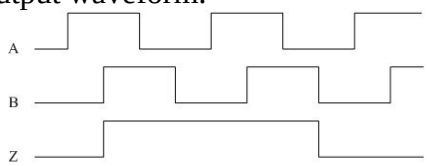

Fig.6 Signal Output Waveform

In order to simplify the design of control module of position servo, trapezoidal velocity generator and digital power error-prevention adjuster inside LM629 are used. Power error-prevention control is:

$$u(k) = K_P e(k) + K_I \sum_{j=0}^{k} e(j) + K_D [e(k) - e(k-1)] \quad (1)$$

Where, u(k) is the result of number k time sampling; e(k) is deviation value of the number k time sampling; KP is proportion coefficient; KI is integral coefficient; KD is differential coefficient.

In order to improve control performance, based on power error-prevention, this system uses fuzzy rule to carry fuzzy inference for system error and error rate; then, it adjusts power error-prevention parameters on line to acquire optimum power error-prevention parameter at a time; this is fuzzy self-tuning, power error-prevention control for parameters.

Error e and error rate $\triangle e$ can be calculated according to actual rotation speed of median filtering for successive two times and rotation speed cycle interval of singlechip computer of chip machine; error and error rate form the input of this controller; for calculation of parameter KP, KI, and KD, obtain corresponding values of basic discourse domain through quantification factors Ke, and $K\triangle e$, then carry out fuzzification, inference, and defuzzification respectively to obtain them.

4. Conclusion

The Thesis aims to design and research a kind of digital power error-prevention and fuzzy power error-prevention DC speed regulating system. In order to make biogas engine system acquire shorter rise time and minimum overshoot, this Thesis uses fuzzy self-tuning power error-prevention parameter control to increase adaptive ability of speed regulating system to controlled objects, and to complete realization scheme for soft hardware based on principles of speed controller.

Acknowledgement

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Reference

[1] Taher S A, Fini M H, Aliabadi S F. Fractional order PID controller design for LFC in electric power systems using imperialist competitive algorithm[J]. Ain Shams Engineering Journal, 2014, 5(1):121–135.

[2] Debbarma S, Saikia L C, Sinha N. Automatic generation control using two degree of freedom fractional order PID controller[J]. International Journal of Electrical Power & Energy Systems, 2014, 58(58):120–129.

[3] Chugh V, Ohri J. GA tuned LQR and PID controller for aircraft pitch control[C]// IEEE, India International Conference on Power Electronics. IEEE, 2014:1-6.

[4] Sahu R K, Panda S, Yegireddy N K. A novel hybrid DEPS optimized fuzzy PI/PID controller for load frequency control of multi-area interconnected power systems[J]. Journal of Process Control, 2014, 24(10):1596–1608.

[5] Pavković D, Polak S, Zorc D. PID controller auto-tuning based on process step response and damping optimum criterion.[J]. Isa Transactions, 2014, 53(1):85-96.