Research on Automation of Test Skill Evaluation Based on Fuzzy Controller

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Abstract. The fuzzy control system is composed of an integral part of modern intelligent automatic control, can control of precision is difficult to directly establish the mathematical model of the intelligent control system object data for effective fuzzy control, so fuzzy has wide application field, considering the basic features of fuzzy control arithmetic, more close to the parallel processing of the way of fuzzy data stream, so fuzzy control is more suitable for implementation by a special control circuit, not only can not only improve the speed of data processing, and it also can improve the control system running stability. With the improvement of programming logic and programmable ability of FPGA, FPGA has the necessary ability to implement ASIC directly and meet the requirements of system programming and design on chip. It has become the development trend of FPGA. The fuzzy analog controller can be used as a digital analog controller of a DC/DC fuzzy converter. In the absence of Matlab/Simulinkc environment, a DC/DC fuzzy converter can be modeled by using Maples toolbox. The simulation test results firstly verify the practical feasibility of the fuzzy analog controller. Then PLXILINXXC3S500EFPGA chip is used to realize the fuzzy simulation controller, and good simulation results are obtained.

1. Realization of fuzzy electronic controller automatic shooting system

1.1. Overall structure design of the controller system
The structure of the top-level control module of the basic design is shown in Figure 1. The design of the fuzzy automatic controller includes a synchronous data signal input and output terminal X1, an automatic synchronous data clock output terminal X2, a synchronous reset terminal CLK and a synchronous data signal output terminal RST.[1-6]
The top-level module of the system design mainly includes three virtual memory for designing and configuring the characteristics of the fuzzy microcontroller system, which are popoints_rom, poly_rom and pocons_rom, as shown in Fig. 2.

**Fig. 2** Fuzzy controller structure

POLY_ROM and CONS_ROM, fuzzy coding controller system structure diagram as shown in figure 2 points_rom storage is mainly used for analysis of fuzzy coding of the controller on the input and output end of the corresponding membership function and the function of upper and lower limits input parameters, because this article is designed for each of the input and output end up has two, respectively, the x1, x2, and we ask that there can be at most two is the membership degree and function and a theory of overlapping domain, so we can be the points_rom divide the data fields in each group of the adjustment of 8 groups:[7-9]
Table 1. Data domain

| X1 | Corresponds to the boundary value of the positive odd-numbered membership function domain; |
| X2 | Corresponds to the boundary value of the domain of the membership function in the even-numbered order; |
| X3 | Corresponds to the boundary value of the positive odd-numbered membership function domain; |
| X4 | Corresponds to the boundary value of the domain of the positive even-numbered membership function domain; |
| X5 | Corresponds to the boundary value of the negative odd-numbered membership function domain; |
| X6 | Corresponds to the boundary value of the domain of the negative even-numbered membership function domain; |
| X7 | Corresponds to the boundary value of the negative odd-numbered membership function domain; |
| X8 | Corresponds to the boundary value of the negative even-numbered membership function domain. |

As shown in table 1, for example, will the group membership at the input and the function is divided into form output respectively odd and input even two kinds, assume that a group of membership degree and function of the corresponding theory of domain is an x1 input output, then the number of positive input sequence of the odd number is called the x1 of membership degree and function in boundary value respectively, including the theory of domain are d, e, f, g four input parameters. By input on this design has two, respectively is: the X1, X, and most have two membership functions have overlapping domain, therefore the POINTS_ROM data can be divided into 8 groups, the input membership functions divided into two categories, the odd and even number, assumes that the membership functions corresponding to the X1 input, the X1 corresponding is an odd number of the sequence boundary value in the theory of membership function domain including d, e, f, g four parameters.

2. Basic application and function of fuzzy analog controller

Verify the fuzzy simulation controller is often used as a validation dc/dc converter application of digital fuzzy controller, in order to validate its basic functions, the application of fuzzy dc/dc converter digital fuzzy controller is usually from the application of digital video monitoring system to simulate the fuzzy control system architecture, digital video process of fuzzy control system architecture, fully digital control system architecture is discussed on three aspects:

2.1. Apply digital video surveillance system to simulate fuzzy control system architecture

In this application, the digital control system sets each reference signal input of each analog fuzzy controller according to the actual power control requirements of the whole system.

2.2. Digital process control architecture

The control algorithm is implemented by sequential logic circuits, such as DSP(Digital Signal Processor) or other microprocessors. (Digital Supervised Analog Control Architecture): In this case, the Digital system sets the reference input of the Analog controller according to the power requirements of the whole system.

2.3. Complete digital control management structure

Different from traditional digital production process control management structure, fully digital control management structure of the system control circuit based on the special digital logic circuit implementation of the controller, the control circuit at least, the user can directly obtain and dedicated analog to digital controller of the same data processing speed, and has the high stability of the system. It is proved by simulation and experiment that a better control effect can be obtained by using the membership function and fuzzy inference rules as described below. The
membership function of the input quantity is shown in Figure 3, from which the data in POINTS_ROM can be determined.

Fig. 3 Membership function of input quantity

Taking SP membership function as an example, it can be decomposable into two combinations of first-order polynomials, \( y = 4x \) and \( y = 4x + \), and then the polynomial expressions of all membership functions can be obtained, that is, the data in POLY_ROM can be determined. The inference rules of the fuzzy controller are shown in Table 2, and the corresponding values are shown in Table 3, thus determining the values in the cons_ROM.

![Membership function](image)

Table 2. Basic table of fuzzy inference operation rules

| Membership function | The numerical |
|---------------------|--------------|
| LN                  | -0.75        |
| MN                  | -0.5         |
| SN                  | -0.25        |
| ZO                  | 0            |
| SP                  | 0.25         |
| MP                  | 0.5          |
| LP                  | 0.75         |

Table 3. Values of fuzzy inference rule table in inference operation results are shown in the following table
3. Experimental results

In the matlab/simulink according to section 3 on the processing parameters set in the table to the fuzzy set, fuzzy inference controller object in a controller object mainly adopts maples (piecewise linear drive electronic control circuit simulation) method, ples can be used as b or a simulation toolbox of the matlab/simulink system, simulation system for industrial high power and the microelectronic circuit simulation device provides a and b or simulink module completely seamless integrated simulation environment directly, can easily complete many difficult on the specific simulation device Simulation experiments are carried out simultaneously and under extreme application conditions. The design of the fuzzy digital controller based on DC/DC series converter is experimentally analyzed, and the design of the fuzzy digital controller based on FPGA is used as the fuzzy digital analog controller based on DC/DC series converter. Good simulation experimental results are obtained, and it is proved that the fuzzy digital controller also has good control characteristics.

4. Conclusion

Fuzzy control has always been valued by the theory and engineering circles, and its algorithm itself has been well known by people, but the traditional hardware and software implementation methods have their drawbacks. In view of the complex situation that advanced fuzzy drive controllers generally lack high speed and low efficiency cost drive control method in modern industrial design and application, this paper focuses on the software design and system implementation of fuzzy drive controllers based on FPGA. It makes full use of the high-speed parallel processing ability of SFPGA, improves the operation speed of the fuzzy motion controller, and establishes the hardware platform for the design of the fuzzy motion controller system. The rapidity, real-time performance and reliability of the fuzzy controller are improved, and the cost is reduced.

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