Yuntai Fuzzy PID Control and Simulation

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Abstract—This article first introduces the basic theory of fuzzy control and design of the general steps of the fuzzy controller, the basic principle of fuzzy PID is presented. Then use particle swarm algorithm to optimize fuzzy rules. In the end, the optimized fuzzy PID triaxial stability for unmanned aerial vehicle haenulda simulation experiment, and make comparison with the classic PID control algorithm. The simulation results show that the PSO parameters optimization of fuzzy PID system has a better effect, optimization of the fuzzy PID control algorithm in unmanned aerial vehicle three axis stabilized yuntai control achieves a good control effect.

Keywords—fuzzy control; fuzzy rules; PID control; simulate

I. INTRODUCTION

Fuzzy control system is a system based on knowledge and rule, and it is a core part of the "if-then" rule knowledge base. Fuzzy control algorithm is the basis of a kind of intelligent control algorithm based on fuzzy set theory, fuzzy language variable and fuzzy logic reasoning. It was based on the fuzzy set, fuzzy relation, fuzzy inference to simulate human thinking and to perform logic judgment, synthesis reasoning, handle and solve routine methods is difficult to effectively solve the problem. Learned the fuzzy control algorithm has the characteristics of fuzziness in the human mind. Broadly speaking, the fuzzy control algorithm is the application of the fuzzy set theory as a whole system of a kind of control method. Part of the fuzzy control system mainly includes the fuzzy processing, fuzzy reasoning, fuzzy, so we choose the combination of different methods, different fuzzy control system can be constructed.

II. YUNTAI FUZZY PID CONTROLLER DESIGN

In the process of simulation, we select yuntai frame as a simulation model of Fig.1. as well as model.

![Figure 1. Fuzzy control system block diagram](image1)

A. the language variable

The camera optical axis Angle deviation E:
Fuzzy comprehensive domain: [3, 3]
Fuzzy subsets: [NB, NM, NS, ZE, PS, PM, PB]
Membership functions take triangular membership functions, as shown in Fig.2:

![Figure 2. error E membership functions](image2)

Deviations rate EC:
Fuzzy comprehensive domain: [3, 3]
Fuzzy subsets: [NB, NM, NS, ZE, PS, PM, PB]
Membership functions take triangular membership functions, as shown in Fig.3:
B. the output language variables

Proportional coefficient increment $\Delta K_p$:
Fuzzy comprehensive domain: [to 30, 30]
Fuzzy subsets: [NB, NM, NS, ZE, PS, PM, PB]
Membership functions take triangular membership functions, as shown in Fig. 4:

Integral coefficient increment $\Delta K_i$:
Fuzzy comprehensive domain: [to 6, 6]
Fuzzy subsets: [NB, NM, NS, ZE, PS, PM, PB]
Membership functions take triangular membership functions, as shown in Fig. 5:

Differential coefficient increment $\Delta K_d$:
Fuzzy comprehensive domain: [3, 3]
Fuzzy subsets: [NB, NM, NS, ZE, PS, PM, PB]
Membership functions take triangular membership functions, as shown in Fig. 6:

C. the fuzzy control rule table

Design of the core part is the summary of technical staff technical knowledge and practical experience, set up suitable fuzzy control table. The following table 1 to table 3 is a kind of for $\Delta K_p$, $\Delta K_i$, $\Delta K_d$ three parameters setting of the fuzzy control table, respectively.
Table 1 Δ Kp fuzzy rule table

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Table 2 Δ Ki fuzzy rule table

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Table 3 Δ Kd fuzzy rule table

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Fuzzy control rule table about ΔKp, ΔKi, ΔKd sets up, and uses the following method for adaptive adjustment.

49 rules of each rule sets with product of reasoning machine, single value center of fuzzy and average solution by combining fuzzy device, namely gets parameters ΔKp, ΔKi, ΔKd online adjustment formula:

\[
\Delta K_p = \frac{\sum_{i=1}^{49} y_i \mu_{\Delta}(e(t)\mu_w(e(t)))}{\sum_{i=1}^{49} \mu_{\Delta}(e(t)\mu_w(e(t)))}
\]

\[
\Delta K_i = \frac{\sum_{i=1}^{49} y_i \mu_{\Delta}(e(t)\mu_w(e(t)))}{\sum_{i=1}^{49} \mu_{\Delta}(e(t)\mu_w(e(t)))}
\]

\[
\Delta K_d = \frac{\sum_{i=1}^{49} y_i \mu_{\Delta}(e(t)\mu_w(e(t)))}{\sum_{i=1}^{49} \mu_{\Delta}(e(t)\mu_w(e(t)))}
\]

Plug in the following equation to calculate the current

\[
K_p, K_i, K_d
\]

III. FUZZY PID SIMULATION RESULTS ANALYSIS

The simulation tool of Matlab is R2010a, fuzzy PID controller using M functional. The initial fuzzy PID controller parameter Kp0 = 19, Ki0 = 0.02, Kd0 = 0. Signal is the unit step signal, sampling time is 1ms.

In order to validate the advantages of the fuzzy PID controller, we put the classic PID and fuzzy PID simulation comparison. The simulation results are shown in Fig. 7.

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We can see from the simulation curve of fuzzy PID regulating time faster, 0.02 s, and the whole process of regulation without overshoot; Classic PID is 0.025 s, there is stable after a steady-state error.

When joining the white noise amplitude is 0.1, the simulation results shown in Fig. 8.

IV. CONCLUSIONS

The simulation results show that the fuzzy PID although can quickly achieve a stable state, but a largesteady-state error, it must add filter technology in control algorithm, to suppress the interference of noise exist in the system, the system has high precision.

REFERENCES