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Fuzzy System Design and MATLAB Application Based on Position Control of Stacker

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***Abstract*—In this paper, laser sensor ranging, combined with fuzzy control algorithm for frequency conversion speed adjustment, to achieve accurate and stable control of stacker. Fuzzy control mimics human thinking mode and has strong adaptability to strongly coupled and nonlinear systems. When the exact mathematical model of the stacker is unknown, the speed increase curve of the stacker is regarded as a ladder curve, without affecting its working efficiency. The case, Improve positioning accuracy as much as possible.**

Keywords—Fuzzy control, stacker

I. Introduction

The main index of the position control system of stacker is the working efficiency and positioning accuracy. However, in the actual design of the speed reduction mode, the working efficiency and positioning accuracy are contradictory and mutually restricting relations. If the speed of the stacker is blindly increased in order to achieve rapidity or the acceleration of braking is increased by delaying the deceleration point, the accuracy of positioning will be affected. On the contrary, it will reduce the efficiency of the stacker operation. In addition, if the acceleration in the start and braking of the stacker is too large, the vertical vibration of the stacker column will increase, the probability of the collapse of the goods will be increased, and the operation and testing mechanism of the goods and stacker will be damaged. In order to solve the above-mentioned contradiction between the two, the traditional control theory method has been difficult to do. Therefore, the advanced control strategy is chosen to apply to the positioning and speed control of the stacker.

II. Design of Fuzzy Controller

In the 1960s, the United States 'L. After AZdahe proposed the fuzzy theory, the theory was gradually applied to many control fields and created a new space. Fuzz Control, a theory based on fuzzy logical reasoning, fuzzy language variables, and fuzzy set theory. Fuzzy logic is different from the simple negation Ken negation in the classical binary logic.

The basic composition of the fuzzy controller is shown in Figure 1. The basic structure includes: fuzzy interface, fuzzy inference machine, rule library, and clear interface. The input of the controller is the difference between the real-time process measurement value and the system setting value. The real-time control correction value of the system is the output variable. The core part of fuzzy control is the rule base and fuzzy inference. Fuzzy inference is a fuzzy set that changes the fuzzy set of input variables into output variables. It is a fuzzy transformation and realizes the transformation of the domain.

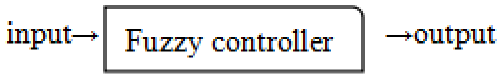

Figure 1 Composition diagram of the fuzzy controller

Although the structure of the one-dimensional fuzzy controller is simple and clear, because the one-dimensional controller only selects the stacker position S as the input, the lack of analysis of its operating speed V will inevitably lead to an unsatisfactory system control effect, so it is not suitable for this system. It is very difficult to determine the control rules of three-dimensional and above fuzzy controllers, and the algorithm is particularly complicated, so it is not suitable. Therefore, the system chooses a two-dimensional fuzzy controller, where the position S and the operating speed V are the two inputs of the controller. The position of the stacker is determined by the laser ranging sensor. The running speed of the stacker is obtained by the feedback output value of the encoder installed on the electric machine. Both inputs are the numbers obtained by Modulo conversion of the A/D conversion circuit on the PLC side. The output is converted from the output digital quantity to the corresponding analog quantity through the PLC D/A conversion module, and the frequency of the inverter output.

III. MATLAB Simulation

MATLAB is a powerful tool for the establishment, research, analysis, simulation, and design of system models in various fields. The simulation of the stacker position control system uses the model simulation visualization SIMULINK function toolbox and FUZZY toolbox in MATLAB. SIMULINK includes two functions: SIM(simulation) and LINK(connection). It is a dynamic system establishment model and simulation environment based on the integration of MATLAB basic language environment. It has programming modularity, graphical, encapsulable, and visualization. The FUZZY toolbox is convenient for users to design fuzzy controllers and connect them to simulation systems.

According to the design of the fuzzy controller, if you enter the command "fuzzy" in the MATLAB command window, the

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FIS editor will pop up, as shown in Figure 2. Add input variables to two in the fuzzy editor, named S, V, and an output U, and the Defuzzification method is selected as "centroid"(center of gravity method).

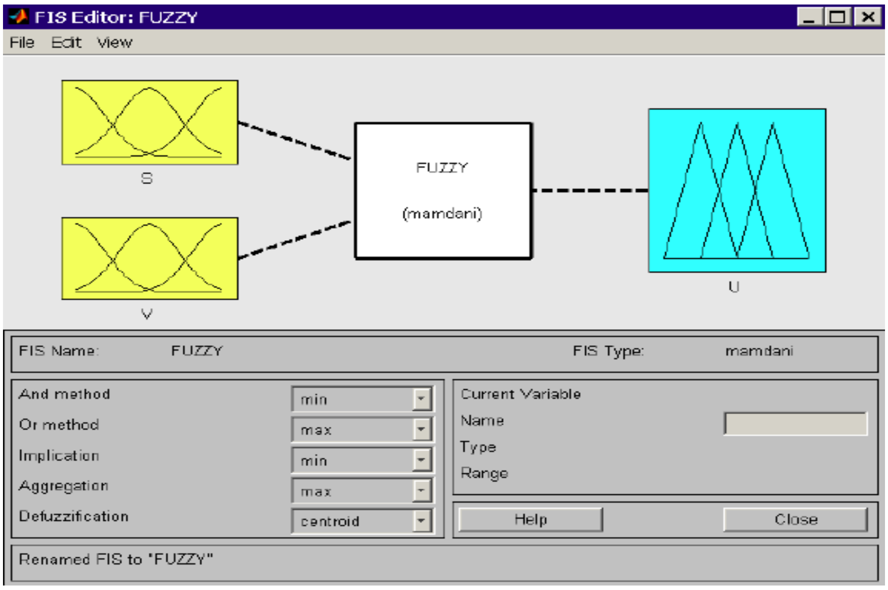

Figure 2 Fuzzy Editor Interface

Then, the membership curve of S and U is drawn in the membership function editor for the input variables S and V. The membership curves of S and U are shown in Figures 3 and 4. The membership curve of V is similar to U, and is not repeated here. From the fuzzy rules, 35 rules are generated using the editor GUI. The surface of the fuzzy inference overall rules is shown in Figure 5.

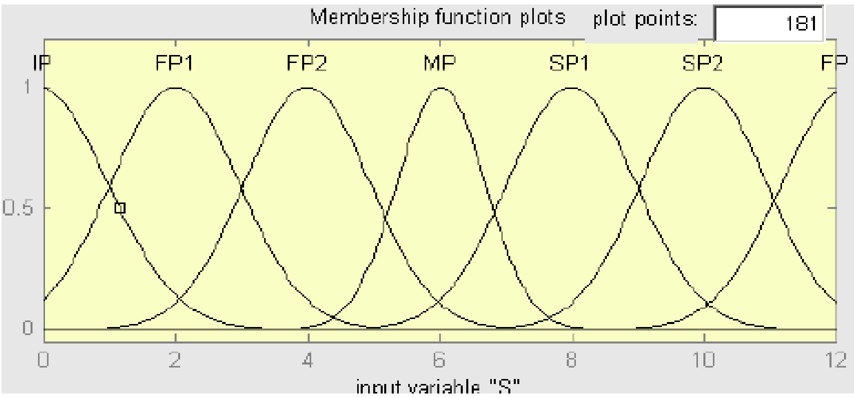

Figure 3 Membership curve of input variable S

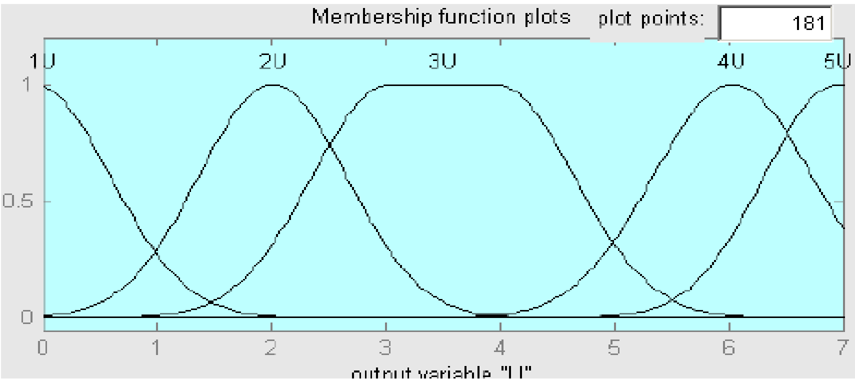

Figure 4 Membership curve of output variable U

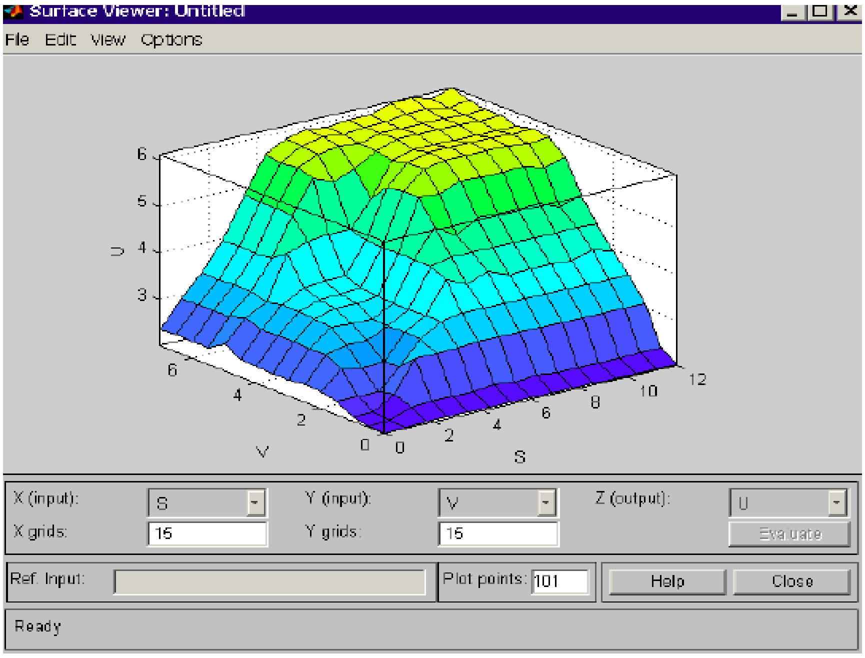

Figure 5 Surface diagram of fuzzy inference rules

In SIMULINK, a control system simulation model block diagram is shown in Figure 6.

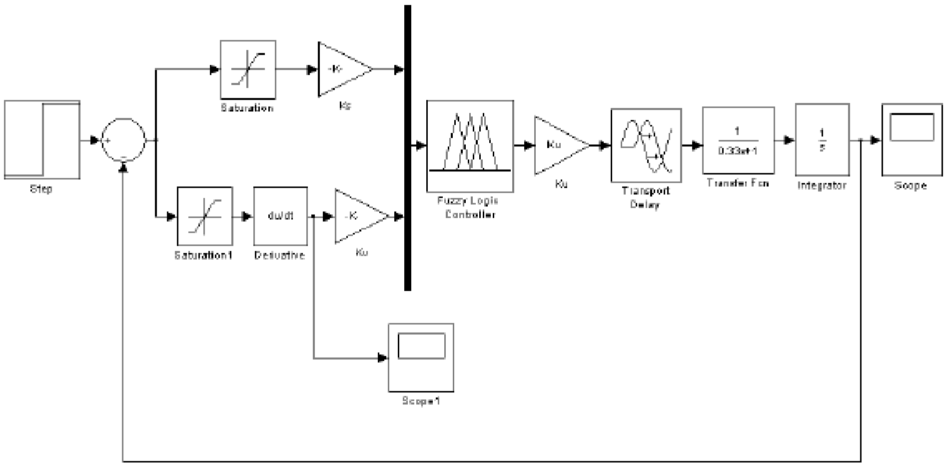

Figure 6 System Simulation Box

According to the design requirements of the system, the actual speed curve of the stacking machine tracks the ideal speed control curve in real time, and the running time is shorter than the traditional method, and at the same time, the system avoids unnecessary overtones.

If the control system does not have an ideal simulation result, it is necessary to adjust the values of Ks, Kv, and Ku to obtain the ideal result. If the result is not satisfactory, the membership function and the fuzzy control rule may need to be re-established. Adjustment.

IV. Implementation of Fuzzy Control PLC

The PLC implementation of fuzzy control is usually to store the query table in the PLC. The flowchart of the variable frequency variable speed fuzzy control process based on the Siemens S7-200 PLC is shown. First, the fields of S, V, and U and the quantitative factors KS, KV, and the proportional factor KU are stored in the PLC's maintenance relay, and the input is collected through the A/D module into the PLC's VW register, and the limit is quantified. The quantized Si and Vj are directly obtained from the sampling and transformation theory fields, and the corresponding control quantity Uij in the corresponding position in the fuzzy controller table is queried. The fuzzy output is obtained, and the actual output is multiplied by the scale factor. After the D/A module output acts on the actuator accordingly, the fuzzy control strategy is realized through the combination of offline calculation and online query, so that the system has good control quality and real-time.

Through testing and practical operation, it is found that the stacking machine using fuzzy control has accurate address, high operating efficiency, and the stability of the system has also been greatly improved.

V. CONCLUSION

Based on the analysis of the transfer function and velocity curve of the position control system of the stacker, the fuzzy algorithm is applied to control the speed of the stacker, and the fuzzy controller is designed to improve the characteristics of the stacker. The fuzzy control of the position of stacker is realized by means of the airborne controller PLC.

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