International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 5 Issue 10 ǁ October. 2017 ǁ PP. 23-28

Research on DC Charger Control Based on Expert Fuzzy PID

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ABSTRACT: In order to solve the demand of charging piles of high-power electric vehicles for electric vehicle charging stations and underground garages, an intelligent electric vehicle charger with maximum output power of 60Kw and adjustable output voltage is designed. This paper is based on the expert fuzzy PID control strategy, the algorithm design, the conventional PID control and expert fuzzy PID control were compared and analyzed, the results show that expert fuzzy PID control response faster, more anti-interference ability, which mainly on the fuzzy The charging rules (charging current, battery voltage and temperature change) are obtained by comparing the conventional PID control and expert fuzzy PID control with the battery status information during the charging process stored in the host computer. The charging data is plotted as a curve. The output current variation curve in the process of charging is in accordance with the analysis of the acceptance rate of the battery charge in the three-law of Mascus, and the trend of the change of the output current is also in accordance with the acceptable charging current curve of the lithium battery. Therefore, the change trend of the output current of the charger This article controls the expected goals of the strategy.

Keywords: expert fuzzy; PID; DC; charger; control

Date of Submission: 05-10-2017 Date of acceptance: 16-10-2017

I. INTRODUCTION

NEW energy vehicles travel tools, as a kind of energy saving for the conservation of existing resources played a very significant role Accelerate the development of new energy vehicles, can improve energy distribution, not rely on the existing resources such as oil, this will help the sustainable development of economy, is also a choice for benign development of the society In the early 1970 s, the United States began to invest heavily to the battery industry, many western countries also joined later, using intelligent fuzzy control technology to make the development of the charger made great achievements The traditional charger as the low power factor and low efficiency Large harmonic content Charging ways such as inappropriate shortcomings, the quality of power grid and battery life caused serious influence.

PID control is one of the control strategies developed a long time ago, which has the characteristics of simple and stable and has been widely used by engineers. Although there are many kinds of control theories, PID control is still a stable and efficient method in the control system of the charging machine. But it is a pity that the conventional PID controller can't real-time correction parameter, and dc charging machine system was also a time to change, the nonlinear systems, it is difficult to develop a precise mathematical model, so the traditional PID control to get a good result is difficult. The model of the fuzzy controller is not very clear structure system can be more simple and precise control, the fuzzy control does not have integral element, but only it is difficult to eliminate the steady-state error, and in the case of variable classification is not enough, there will be a small fluctuations near the balance point. Therefore, combining these two methods, it is possible to construct a high-precision controller with both advantages

In this paper, the control of conventional PID control and fuzzy PID control are compared, and the advantages of fuzzy PID control are mainly reflected.

II. DESIGN OF CHARGING PILE CONTROL SYSTEM

A.Circuit frame design of main circuit

Primary loop phase shift by multiple magnetic circuit by get 800 v dc rectifier module, all of the charger charging stations in parallel on the dc bus terminal transformer total power of 700 kw, PC can be dynamically allocated by the background all the power charger, main loop circuit diagram is shown in figure 1.

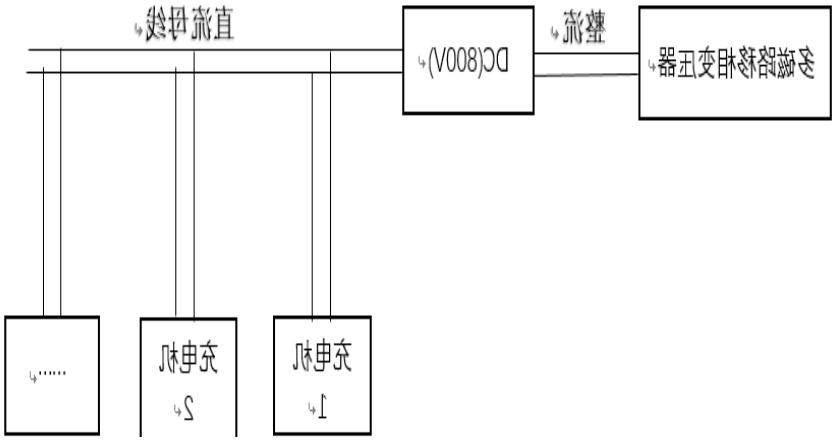


Fig. 1 circuit block diagram of main circuit

B.Software system design

When charging pile software design adopts the modular programming ideas, this can guarantee the stability of electric vehicle charging pile software system speed, and make the software system has the very good ductility, has an irreplaceable role to the product renewal.According to the charging pile the function of the software system can be divided into master control module, human-computer interaction, the system card reader module, measuring the billing module, print module, the background communication module, the remote communication module function module.When need to recharge electric cars, electric cars, the user will recharge card close to the credit card area, according to the instructions of the display screen by the next steps, connect the charging port, select the corresponding charging mode, then start charging.In the normal connection of the charging interface, start the charging button and stop charging immediately if the connection appears abnormal. During the charging process, the charging voltage, current and interface connection state are monitored in real time. When an abnormal or malfunction occurs, disconnect the charging switch and stop the output current voltage. The charging pile software consists of many modules, which can be combined together to realize the charging function. The overall control flow chart of the system is shown in figure 2.

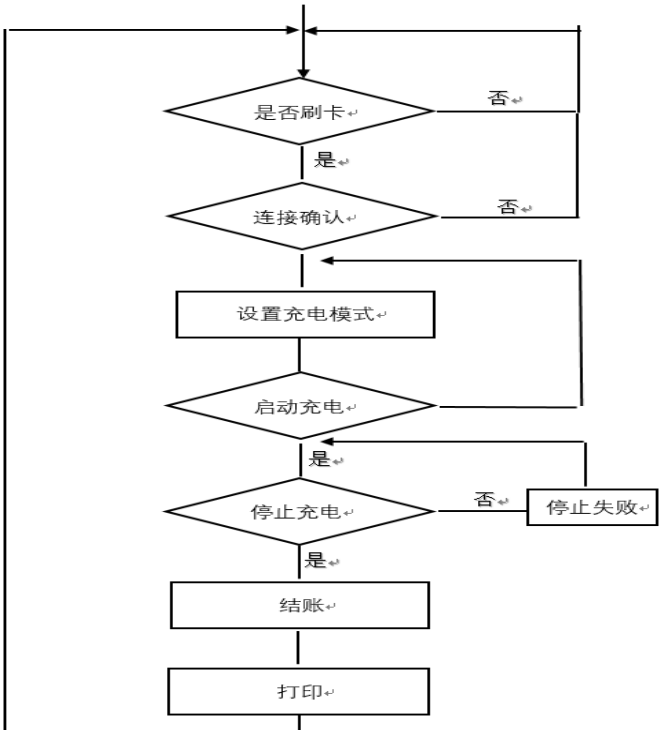


Fig. 2 main program flow chart of charging pile software system

Graphic display interface design, interface display unit content are many, the main interface with the welcome screen, confirm and charging parameters setting interface connections, start charging, charging interface, stop charging interface, the invoicing interface, printing, etc. The human-computer interaction module can get the control command to complete the interface switch by interacting with the main control module; Obtain user information and real-time data information and display information.

III.CONTROL STRATEGY AND ALGORITHM

A.conventional PID control

At present, conventional PID control is widely used in industrial control, and the PID control of classical PID control is controlled by PID control and incremental PID control. The position PID control algorithm is:

$$u(k) = k_p e(k) + k_i T \sum_{j=0}^{k} e(j) + k_d \frac{e(k) - e(k-1)}{T} \quad (2\text{-}1)$$

In the formula: k is the sample number, T is the sampling time.

Incremental PID control is also widely used in industrial control system. Its specific control algorithm is:

$$u(k) = u(k\text{-}1) + k_p[e(k) - e(k\text{-}1)] + k_i e(k) + k_d[e(k) - 2e(k-1) + e(k-2)] \quad (2\text{-}2)$$

According to the output characteristics of the charging machine control system, if the output voltage of the charger is too large, it can easily damage the battery life. In this paper, incremental PID control is used as the control algorithm of this system.

B. Expert fuzzy PID control

Is defined as a class contains knowledge of expert system and fuzzy reasoning automated computer programs, it mainly includes a level of experts in the industry knowledge and related experience, and have the ability to solve the problem of clear, knowledge base and reasoning machine of expert system.

Expert PID control principle is the accurate model of controlled object under the condition of unknown, according to the control object of all kinds of knowledge and a variety of control rules, expert experience is used to design the PID parameters, the expert rules can be written in the form of "IF... THEN..." Statements.

This article selected for two input three output of the fuzzy controller, the input of fuzzy controller are respectively system error e and error change ec, output are respectively KPC, kic, KDC, here the KPC, kic, KDC is the variation of KP, ki, kd. MATLAB software provides the fuzzy reasoning toolbox, can realize the fuzzy control simulation. Enter FUZZY in the command window, which shows the graphical user interface (GUI) shown in figure 3, and double-click the corresponding module, which is the edit of the control rules and membership functions.

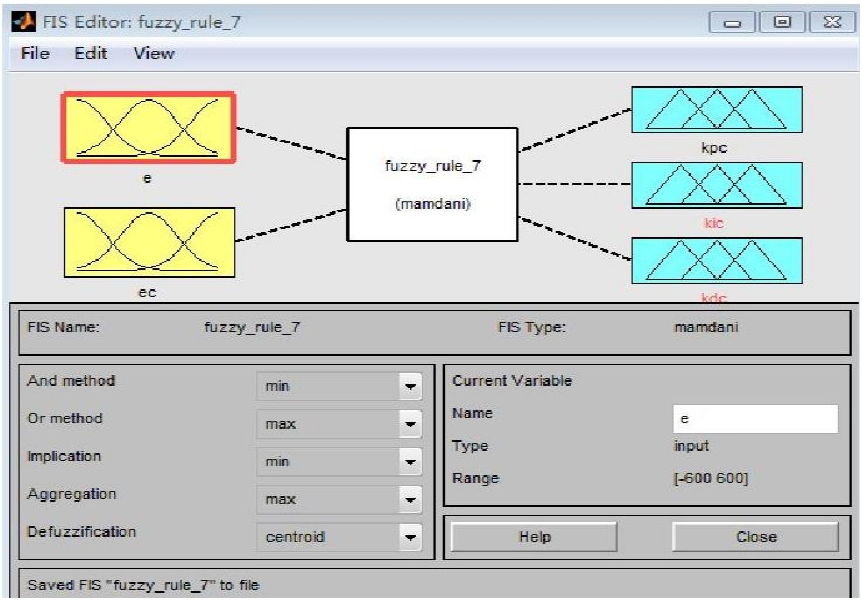
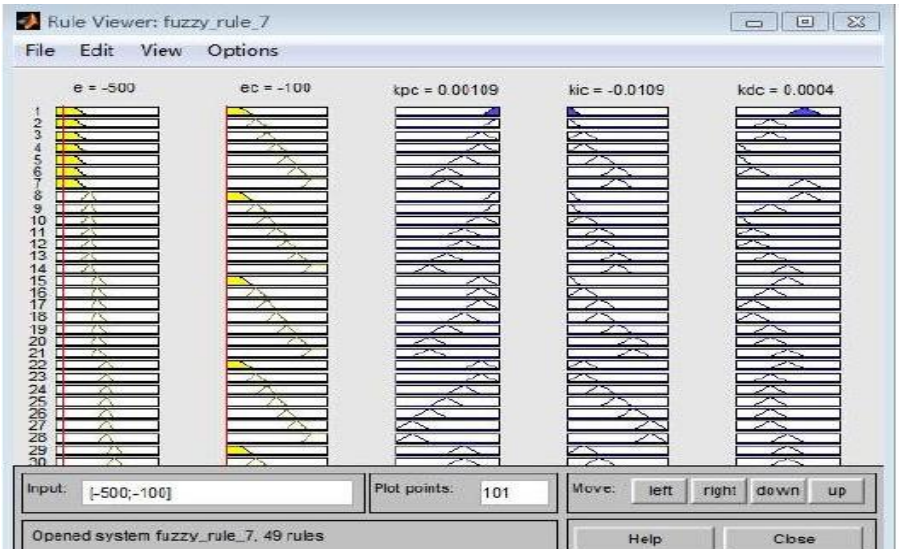


Fig. 3 graphical user interface

After fuzzy reasoning for fuzzy set, cannot be directly used in control system, the fuzzy set must be on an obscure can obtain the accurate control values, in this paper, the fuzzy controller USES the gravity method as a way to the blur. The principle of gravity method is to first take abscissa and membership function curve of the closed area, taking the area of the enclosed area of center of gravity as a result of fuzzy reasoning, namely the system in order to get accurate control values. In this paper, the fuzzy reasoning toolbox in MATLAB is used to design the fuzzy controller, as shown in fig.5. When e is -500 and ec is -100, the output of the corresponding

fuzzy controller is KPC = 0.00109, kic= -0.0109, KDC = 0.0004.



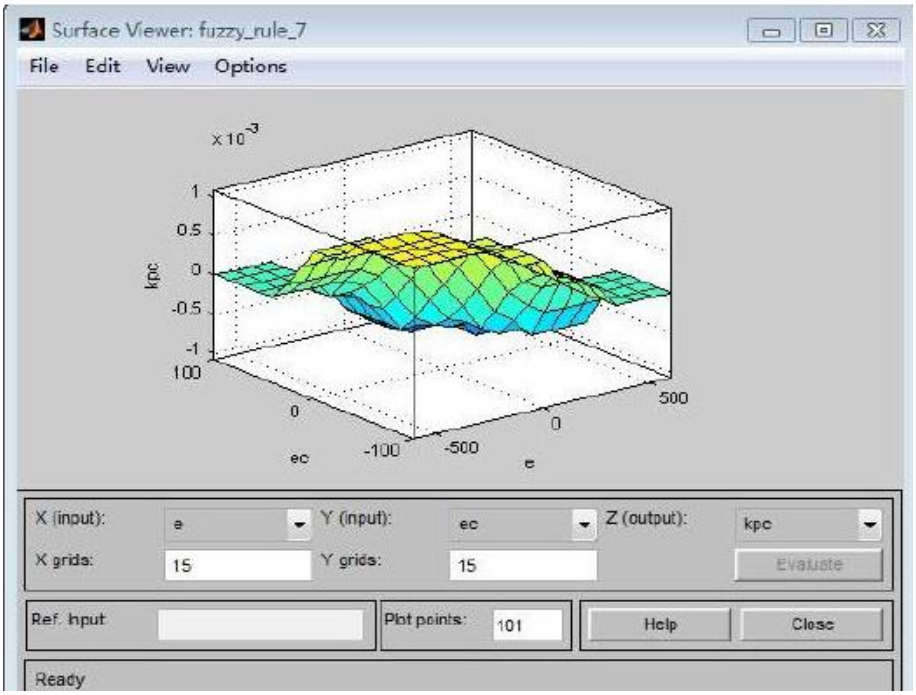


Fig. 4 the output of the fuzzy controller

IV. CONTROL STRATEGY RATIONALITY TEST

The test of the control system performance of the design is mainly to test the control strategy, namely the test of the rationality of the strategy. On the one hand, the output voltage model established by the expert fuzzy PID control is simulated by the expert fuzzy PID control, and the control effect is compared and analyzed. On the other hand, can according to the charging test process, the charger output current is following the above analysis of lithium battery charging electric current curve and acceptable change to judge whether the design is reasonable, at the same time by detecting the battery internal temperature changes to verify the stability of the charger output .

A. comparison of expert fuzzy PID control effect

The difference between the expert fuzzy PID and the conventional PID is to add the expert fuzzy rule library, which can adjust the PID parameter value in real time, so that the whole system can achieve a better control effect. As shown in fig.6, the error output graph is shown in figure 7. It is easy to see that the stability of

fuzzy PID control in the expert is better, the time of stable value is about 0.1 s, and the voltage rise is also fast .

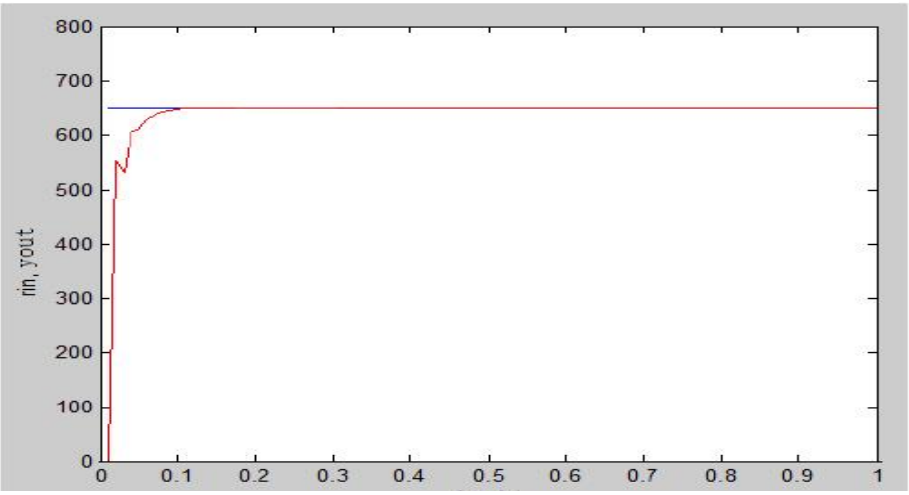


Fig. 5fuzzy PID output of constant pressure phase

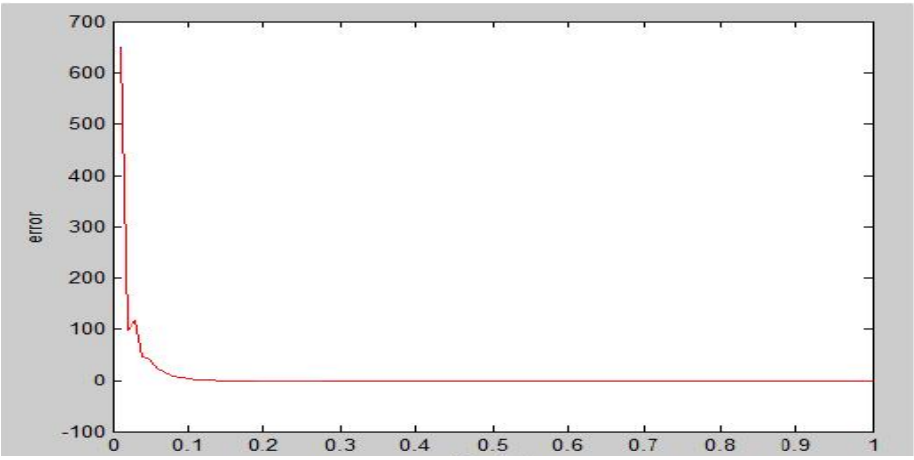


Fig. 6 fuzzy PID error output diagram

B. the charging effect of fuzzy PID control in home

For expert fuzzy PID control for the effect of the whole machine can charge based on the tests, the change of the output current to judge whether the design is reasonable, the output current is following the above analysis of the lithium iron phosphate battery charging electric current curve and acceptable change, this paper select the lithium iron phosphate battery f300 REF - 105, its specific parameters are as follows: the battery type for Li Fe PO4, battery capacity is 300 ah, nominal battery voltage is 336 v. The selection of BMS is from hangzhou siensi technology co., LTD..

The output information of the charging machine is measured by the peripheral equipment, and the actual output value and the set value of the charger are compared, and the status change of the battery is monitored through the upper computer interface of BMS to prevent the failure of charging control. Charging according to the above segmentation analysis, charging current for the 6 a charging stage, stage of constant-current charging charging current ratio of 0.4 C or 120 a, constant voltage phase the charging voltage unchanged, at this time due to the voltage of the battery charging current resulted from the rising continues to decline, the whole process to stop charging standard is: constant voltage charging stage of charging current down to 1/10 of the constant current charging phase current stops charging, at this point the entire charging process is complete.

The charging data (charging current, battery voltage and temperature changes) can be obtained by the battery status information in the charging process stored by the upper computer, and the charging data is plotted into a curve. In this paper, the design of the charger output current changes in the process of charging curve is shown in figure 10, on the basis of the second chapter to the lithium battery and lithium battery charging method analysis of the measured curves of output current in line with the three laws of mas in the analysis of battery

acceptance rate, and the tendency of changes in the output current is also follow the lithium battery charging electric current curve and acceptable change, so the charger output current trends, in [10] in this paper, the control strategy of the expected target.

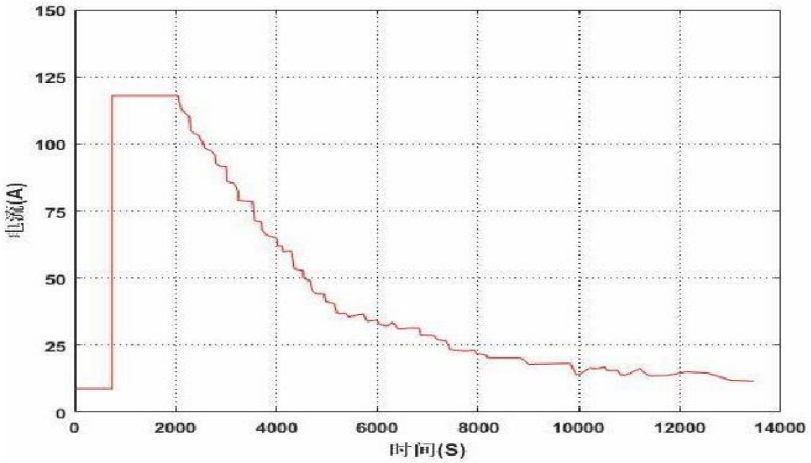


Fig. 7 output current curve of the charger

V. CONCLUSION

(1) based on expert fuzzy PID control of theoutput current curve follows a lithium battery charging electric current curve and acceptable change, so the charger output current trends, conforms to the anticipated target of the control strategy in this paper.
(2) the expert fuzzy PID control response is faster than the conventional PID control, and the output voltage value can be achieved faster
(3) expert fuzzy PID control is much better than conventional PID control

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*Yu Zhang. "Research on DC Charger Control Based on Expert Fuzzy PID." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) , vol. 05, no. 10, 2017, pp. 23–28.