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The Research On Direct Self Control System Of Asynchronous Motor Strong Anti-disturbance Ability

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Abstract*:* Direct self control system for asynchronous motor, the control system in the condition of large disturbance, the control effect is not good problem ,put forward a new type of Automatic speed regulator(ASR).The new type of ASR use subsection control .According to the deviation value of ASR input to subsection control use subsection control. When the error is big, Use improved proportional integral control. While the error is small, the fuzzy control is adopted. And the improved proportional integral control will be based on the rules, to connect or disconnect the integral control function of the improved proportional integral controller. By comparing the simulation results with Matlab/sumlink, Prove that the new scheme of Anti-disturbance performance is better than the classical.

Keywords: asynchronous motor; Direct self control; Automatic speed regulator; Subsection control; Rules integral

INTRODUCTION

Direct self control (DSC)(M. Depenbrock, 1988) also known as direct torque control(DTC) (Isao, et. al. 1986) is one of the Variable Voltage and Variable Frequency(VVVF) control strategy (Li, *et. al.*, 2009). Compared with the vector control, which is the same efficient well-known. The direct self control of the motor and the inverter is considered as a whole. The given values of electromagnetic torque and stator flux linkage are calculated. Then by comparing the actual value and the calculated value of the given. The direct self control of the motor and the inverter is considered as a whole. The given values of electromagnetic torque and stator flux linkage are calculated. Then by comparing the actual value and the calculated value of the given. Optimal control of the switching state of the transformer by hysteresis comparator. Thus, the flux and torque are controlled directly, and then the high dynamic response of the motor is obtained(Xie, *et. al.*, 2008). Therefore, it is not needed to convert the AC motor into equivalent DC motor as the vector control, so the steps of decoupling the stator current and the vector transformation are omitted, so that the complicated calculation is avoided and the fast response speed can be obtained. By comparing the direct self control and vector control, the control method of the former is clear and direct, the physical concept of control signal processing is clear, the control structure is simple and fast response of electromagnetic torque (Wang, *et. al.*, 2013), which reflects the development direction of the control strategy of variable frequency speed regulation.

Therefore, to maintain the original advantages of direct self control, to further obtain better anti-interference ability and stability, this paper proposes a novel Automatic speed regulator (YAN, et. al., 2009), based on the fast adjustment of large errors, small error precise adjustment of the control idea, using a proportional integral controller with the rule of parallel fuzzy control mode to speed control of asynchronous motor.

IMPROVED AUTOMATIC SPEED REGULATOR

Traditional PI controller

The core of the Automatic speed regulator is proportional integral controller, the proportion (P) and integration (I) are controlled by a linear combination of the common action of the formula, and its formula is shown below.

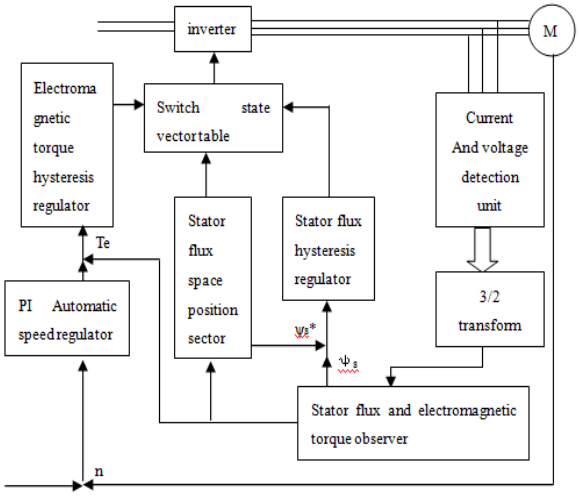

Figure 1. Direct Self Control (DSC) System

$$u(t) = K_p\left\{e(t) + \frac{1}{T_i}\int_0^t e(t)\right\} \qquad (1)$$

The strength and the ratio control part will be the input of error in proportion decreases, and the adjusting speed and the proportion coefficient is directly proportional to the, but proportion coefficient greater than the small, it will have a negative impact on the system control and integral control part can be input error decreases to integral proportional relationship, and the errors are eliminated according

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to the increase of the time and enhanced. So pure proportional control and pure integral control have their own advantages and disadvantages. The former has a quick response and no lag problem. However, it has the problem that the error can not be eliminated completely. While the latter has a complete elimination of errors, its own hysteresis characteristics, that is, the dynamic response is slow, which has a bad effect on the stability of the control system. The proportional integral control overcomes the problem of the error of the pure proportional control and the dynamic response of the pure integral control, so it is widely used.

Rule integral PI controller

Although the traditional PI controller can overcome the disadvantages of pure proportional control and pure integral control, the control system can quickly reach the preset speed in order to make the asynchronous motor speed up to a preset speed. During this period, a very large error disturbance can be easily beyond the control function of the controller. Therefore, the control system of the motor speed control can be reduced. Therefore, a proportional integral controller is adopted, and its principle block diagram is shown in Figure 2.

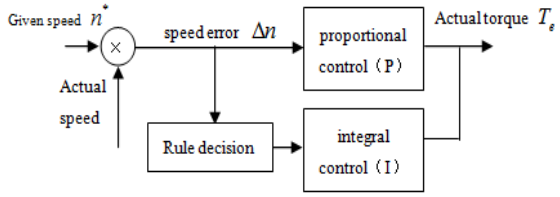


Fig.2 Rules integral PI controller

This proportional integral controller will be used in the control of the motor speed control system after the operation, the Automatic speed regulator input is set for a given speed and the actual speed of the asynchronous motor, that is, the speed error, and sent to the proportional control module and rule, the rule decision module will be based on the requirements of the rules, according to the size of the speed error, the control module control module. When the motor speed control system is in the starting phase or asynchronous motor speed and the difference of the speed error value is bigger, the rule judgment module will break, cancel the integral controller in the system function, the Automatic speed regulator only proportional control system in separate work, can be considered as a pure proportional controller, in this condition, the proportional controller without lag and quick response to reduce the adjustment time, thus speeding up the speed regulation of asynchronous motor. When the motor speed control system to complete a rough fast speed adjustment of the actual speed and the differential speed of the given speed, the rule of the module will be integrated module, the integral controller in the control system, the Automatic speed regulator that is the traditional control system, proportional control and integral control in the system, so as to reduce the error caused by pure proportional control, and then obtain a more excellent control performance.

Pure proportional control will be taken over a period of time by proportional integral control.

$$n_{PI} = n^* \pm \Delta n \qquad (2)$$

Traditional fuzzy PI controller

As an important branch of modern intelligent control theory, fuzzy control is often used in series with proportional integral controller in the Automatic speed regulator of direct self control system, and the principle block diagram is shown in Figure 3.

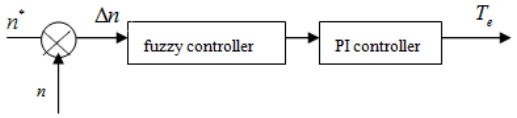


Fig.3 The traditional fuzzy PI controller

Fuzzy controller has four modules, which are obfuscated, Fuzzy Knowledge Database(fuzzy database, fuzzy rule base), Fuzzy Inference Engine and defuzzification. The structure of the block diagram is shown in Figure 4.

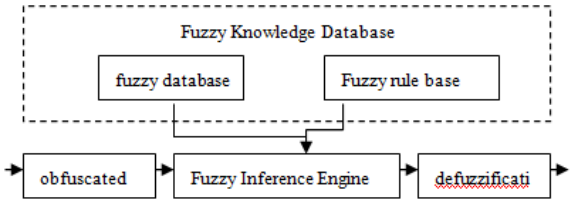


Fig.4 The fuzzy controller

The Automatic speed regulator in this series, the fuzzy controller will be based on the input variable speed difference *E* and speed difference *Ec*, the integral coefficient of the proportional integral controller and the proportion coefficient of real-time adjustment, so that the control system to obtain good dynamic and static performance.

Automatic speed regulator of rules integral PI controlled parallel with fuzzy control

Fuzzy control of high precision adaptive algorithm is often more accurate, but the algorithm is complex, it will reduce the operating speed of the control system, so the fuzzy control is not suitable for a wide range of regulation, but can effectively enhance the ability to resist disturbance. Therefore, on the basis of the PI controller based on rule integral, the fuzzy control is used in parallel. The principle block diagram of this Automatic speed regulator is as follows.

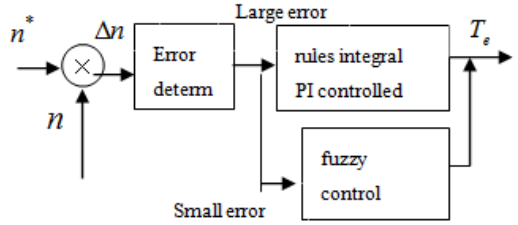


Fig.5 Improved PI rules integral controller

In this paper, the fuzzy controller using the dual input single output Mamdani model, using Centroid to judge, the form of its function as follows: [7].

$$U = \frac{\sum_{j=1}^{n} b_j^k \cdot j}{\sum_{j=1}^{n} b_j^k} \cdot j \quad (4)$$

The membership functions of the three variables are the triangular function, the input of the fuzzy variable fuzzy deviation *E*, the fuzzy deviation change rate *Ec*, which is defined as follows.

$$E(t) = n^*(t) - n(t) \quad (5)$$

$$E_c(t) = \frac{[E(t) - E(t-1)]}{T} \quad (6)$$

Type in $n(t)$ is actual speed when time is t, $n^*(t)$ for the given speed when time is t, T for the sampling time.

Fuzzy quantity E, Ec of the domain are[-66],The output of the U domain is [-7 7],The fuzzy quantity E fuzzy set is {NB,NM,NS,NO,PO,PS,PM,PB},The fuzzy sets of fuzzy quantity Ec and output U are {NB,NM,NS,ZO,PS,PM,PB},

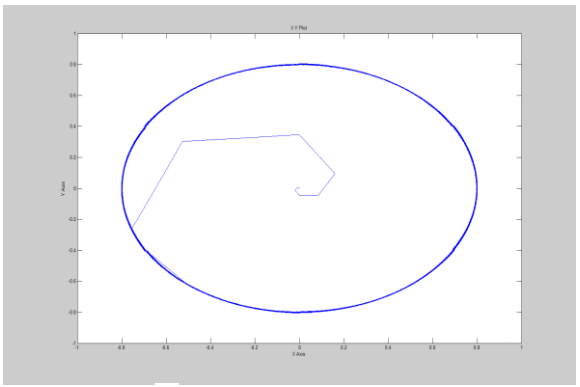
This new type of ASR will use the method of subsection control, the input is the difference between the actual speed and the given speed, the error estimation module will be based on the size of the speed error, the fuzzy control and the proportional integral control of the rules of the. When the rotational speed error is large, the error judgment module will be connected with the rule integral proportional integral controller, while the fuzzy controller is disconnected, and the speed error is relatively small.

SYSTEM SIMULATION

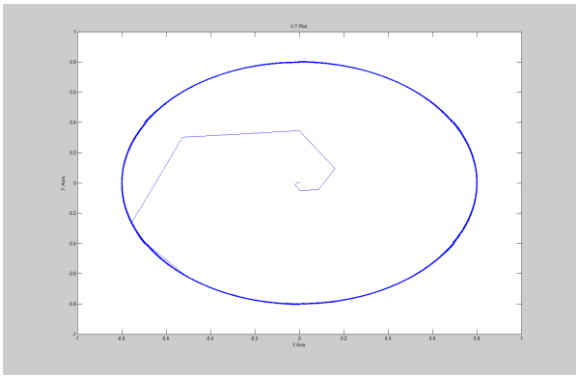
In order to verify the performance of this new type of speed regulator, the Simulink MATLAB function is simulated, and the direct self control model based on the new speed regulator and the direct self control model based on the traditional PI controller are established, and the comparison experiment is carried out.

The motor adopts the squirrel cage asynchronous motor, with the parameters set for: power rating P_n=1.5KW, Rated line voltage V_n=400V, rated frequency f_n=50Hz, stator resistance R_s=0.2147Ω, Stator leakage inductance L_{ls} =0.000991H, rotor resistance R_r'=0.2205Ω, rotor leakage inductance L_{lr}'=0.000991H, mutual inductance L_m=0.6419H,rotor inertia J=0.102kg • m ² ,friction coefficient F=0.009541N. • m • s, pole-pairs$p$=2,input voltage DC=490V,the amplitude of stator flux is 0.8W_b.The PI parameters of the two automatic speed regulator are consistent, Kp=50，Ki=10。

(1)In order to test the load torque of the anti disturbance ability, asynchronous motor empty load start, after 0.4 seconds, the step to T_L=60N m, start at a given speed of 1420r/min, and will be in 0.5 seconds to step up to 1200r/min.



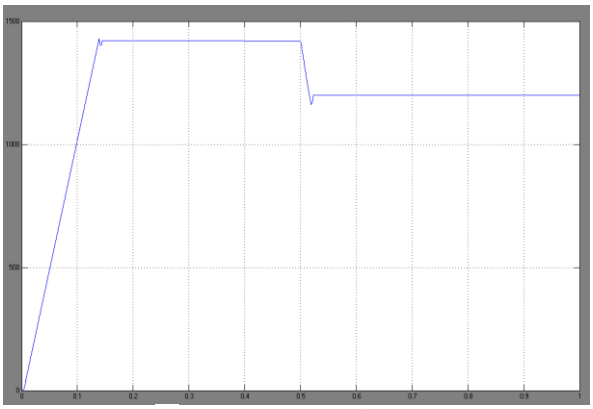
(a) Traditional direct self control



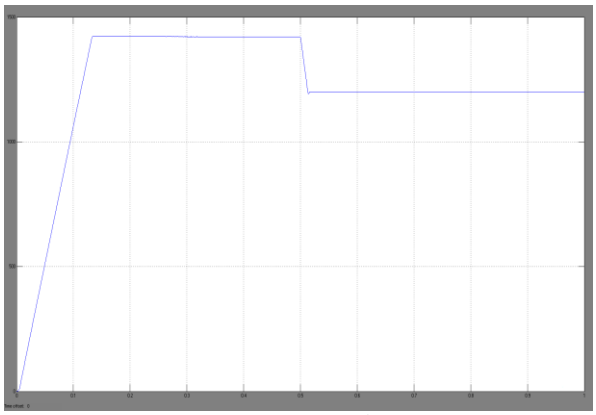
(b) Improved direct self control

Fig.6 The stator flux linkage

The stator flux track is similar, but the fluctuation of the stator flux track is significantly reduced compared to the traditional direct self control system, and it can also be said that the fluctuation range of the stator flux amplitude becomes narrower;



(a) Traditional direct self control



(b) Improved direct self control
Fig.7 The motor speed

The electromagnetic torque waveform of the direct self control system using fuzzy control technology, in addition to the regulation becomes more smooth, there is a small elimination of pulsation phenomenon. This point is in a stable state of 0.4 seconds and 0.5 seconds, the two set of the value of the jump, there is no larger overshoot. The changes of the waveform of the improved system are also smooth.

Through the comparative analysis of the simulation results, we can see that the improved motor direct self control scheme, in the motor start, speed and load step, and the low speed state than the traditional direct self control system showed a better control effect and anti disturbance ability, the system stability is better.

CONCLUSION

In this paper, a new scheme of proportional integral control of parallel fuzzy control is proposed, which is based on the traditional direct self control. This Automatic speed regulator, first through the error judgment module, will be with the rule of the proportional integral control and fuzzy control in parallel use, followed by the rule of integral proportional integral control, according to the rules of the rules to determine the rules of the rules, the control of the integral control. Through simulation results, it is proved that the scheme can effectively enhance the anti disturbance ability of the system while keeping the traditional advantages of traditional direct control, thus improving the performance of traditional direct self control. The research results of this paper lay the foundation for the better control of the motor, but also can be extended to the relevant control system.

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