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FUZZY BASED SPEED CONTROL OF PMSM WITH QUASI Z-SOURCE AND ENERGY STORAGE SYSTEM

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Abstract
This Paper presents an intelligent Speed control system based on fuzzy logic for a voltage source PWM inverter-fed of Permanent Magnet Synchronous Motor. Quasi z-source is used to maintain the power constant throughout the operation and also to boost the voltage. Fuzzy controller based on fuzzy set theory is proposed. The performance of the intelligent controller has been investigated through digital simulation using MATLAB-SIMULINK package for different operating conditions such as sudden change in reference speed and load torque. The simulation results demonstrate that the performance of the proposed controller is better than that of the conventional controller.

Keywords: Fuzzy Logic, Fuzzy Controller, Speed Control, Permanent Magnet Synchronous Motor.

I. Introduction

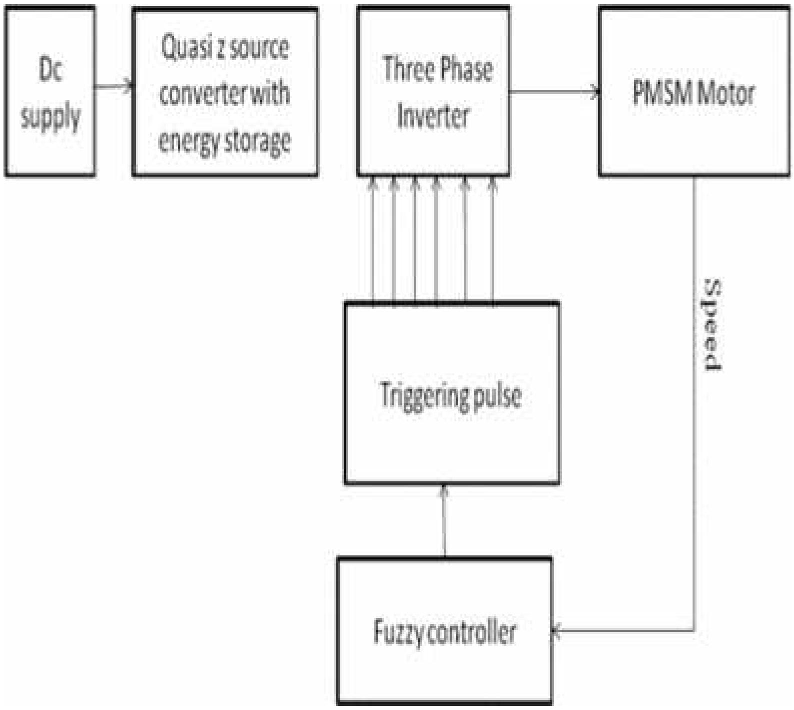
FOR electrical drives good dynamic performance is mandatory so as to respond to the changes in command speed and torques. The traditional indirect vector control system uses conventional controller in the outer speed loop because of the simplicity and stability. However, unexpected change in load conditions or environmental factors would produce overshoot, oscillation of motor speed, oscillation of the torque, long settling time and thus causes deterioration of drive performance. To overcome this, an intelligent controller based on Fuzzy Logic can be used in the place of PI regulator. The fuzzy logic has certain advantages compared to classical controllers such as simplicity of control, low cost, and the possibility to design without knowing the exact mathematical model of plant .

In this paper application of fuzzy logic to the intelligent speed control of Permanent Magnet Synchronous Motor is investigated. design simulation of controller have been carried out based on the fuzzy set theory.
When a new control strategy of a converter or a drive system is formulated, it is often convenient to study t he system performance by simulation before building the breadboard o r prototype.

The simulation not only validates the systems operation, but also permits optimization of the systems performance by iteration of its parameters. Besides the and circuit parameters, the plant parameter variation effect can be studied. Valuable time is thus saved in the development and design of the product, and the failure of components of poorly designed systems can be avoided. The simulation program also helps to generate real time controller software codes for downloading to a microprocessor or digital signal processor. Many circuit simulators like PSPICE, EMTP, MATLAB/SIMULINK incorporated these features. The advantages of SIMULINK over the other circuit simulator are the ease in modeling the transients of electrical machines and drives and to include controls in the simulation. To solve the objective of this paper MATLAB/ SIMULINK software is used. The superior control performance of the proposed controller is demonstrated at SIMULINK platform using the fuzzy logic too l box [for different operating conditions.

II. Working Principle of Operation

The block diagram of the working of fuzzy based speed control of PMSM in which the dc supply is fed to the quasi z source where it is used to boost the voltage and also to maintain the power constant throughout the operation of speed control. This supply is given to the PMSM the motor speed is given to the fuzzy controller .Then the control signal from the fuzzy controller is given to the three phase inverter by triggering pulses.



III. Facts Controller

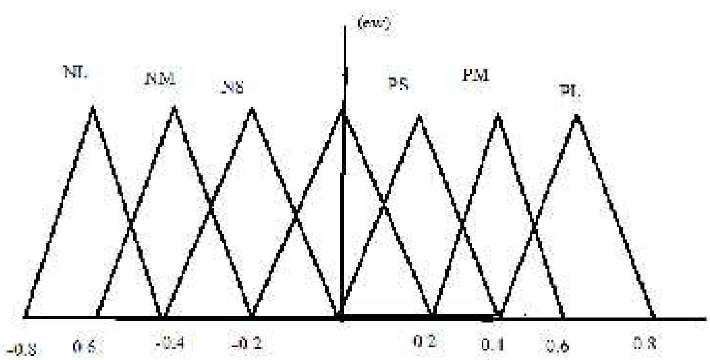
A. Input/ Output Variables

The design of the fuzzy logic controller starts with assigning the input and output variables. The most significant Variables entering the fuzzy logic speed controller has been selected as the speed error and its time variation. Two input variables *e*ω(*k*) and *ce*ω(*k*) are calculated at The output variable of the fuzzy logic speed controller is the variation of command current, *Ciqs(k)* which is integrated to get the reference command current

B. Fuzzification

The success of this work, a nd the like, depends on how good this stage is conducted. In this stage, the crisp variables *e*(*k*) and *ce*(*k)* are converted in to fuzzy variables *e*(w) and *ce*(w) respectively. The membership functions associated to the control variables have been chosen with triangular shapes.

The universe of discourse of all the input and output variables are established as (-0.8, 0.8). The suitable scaling Factors are chosen to brought the input and output variables to this universe of discourse. Each universe of discourse is divided into seven overlapping fuzzy sets: NL (Negative Large), NM (Negative Medium), NS (Negative Small), ZE(Zero), PS (Positive Small), PM (positive Medium), and PL(Positive Large). Each fuzzy variable is a member of the subsets with a degree of membership varying between 0(non-member) and 1 (full-member). All the membership functions have a symmetrical shape with more crowding near the origin (steady state). This permits higher precision at steady state.



(a)

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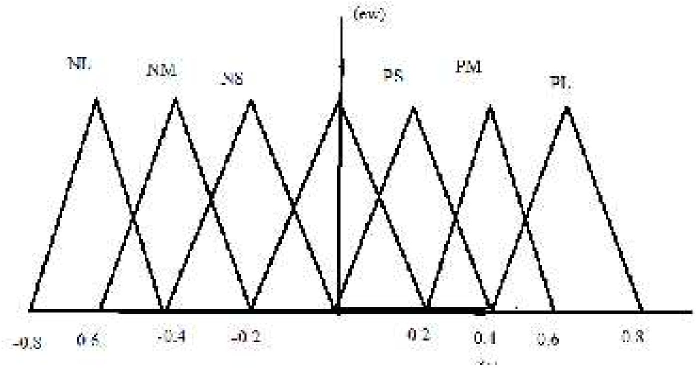
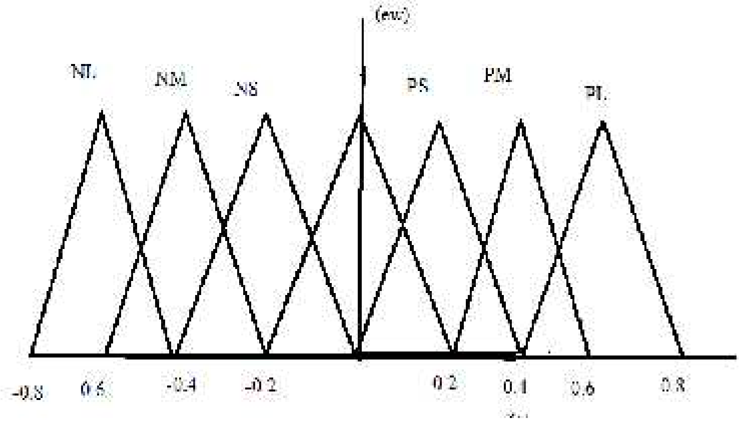


(b)



(c)

Membership functions for (a) speed error (b) change of speed error (c) Change of command current.

C. Knowledge Base and Inference Stage

Knowledge base involves defining the rules represented as IF-THEN statements governing the relationship between input and output variables in terms of membership functions. In this stage, the variables *e*w and *ce*w are processed by an inference engine that executes 49 rules (7x7) as shown in Table I. These rules are established using the knowledge of the system behavior and the experience of the control engineers. Each rule is expressed in the form as in the following.

Example: IF (*e* is Negative Large) AND (*ce* is Positive Large) THEN (**ciqs* is Zero). Different inference engines can be used to produce the fuzzy set values for the output fuzzy variable **ciqs* . In this paper, the Max-product inference method higher precision .

Table I: Fuzzy Control Rules

ce e	*NL*	*NM*	*NS*	*ZE*	*PS*	*PM*	*PL*
NL	*NL*	*NL*	*NL*	*NL*	*NM*	*NS*	*ZE*
NM	*NL*	*NL*	*NL*	*NM*	*NS*	*ZE*	*PS*
NS	*NL*	*NL*	*NM*	*NS*	*ZE*	*PS*	*PM*
ZE	*NL*	*NM*	*NS*	*ZE*	*PS*	*PM*	*PL*
PS	*NM*	*NS*	*ZE*	*PS*	*PM*	*PL*	*PL*
PM	*NS*	*ZE*	*PS*	*PM*	*PL*	*PL*	*PL*
PL	*ZE*	*PS*	*PM*	*PL*	*PL*	*PL*	*PL*

D. Defuzzification

In this stage a crisp value of the output variable *ciqs k* is obtained by using height defuzzufication method, in which the centroid of each output membership function for each rule is first evaluated. The final output is then calculated as the average of the individual centroid, weighted by their heights (degree of membership) .

IV. Conclusion

By using fuzzy logic controller a fast response of speed and torque control is achieved in PMSM. Fuzzy logic software will definitely provide better monitoring control and protection. Then the output voltage is boosted using the quasi z –source. It is providing improved efficiency and improved system performance..The current and torque ripples in the conduction region are eliminated by using the fuzzy logic.

References

1. Changliang Xia, Senior Member, IEEE, and Xinmin Li, “Z-Source Inverter-Based Approach to the Zero-Crossing Point Detection of Back EMF for Sensorless Brushless DC Motor”., IEEE Transactions on power electronics, vol.
2. J. Fang, W. Li, and H. Li, “Self-compensation of the commutation angle based on DC-link current for high-speed brushless DC motors with low inductance,” IEEE Trans. Power Electron., vol. 29, no. 1, pp. 428–439, Jan. 2014.
3. X. Zhou and J. Fang, “Precise braking torque control for attitude control flywheel with small inductance brushless DC motor,” IEEE Trans. Power Electron., vol. 28, no. 11, pp. 5380–5390, Nov. 2013.
4. Y. Liu, J. Zhao, M. Xia, and H. Luo, “Model reference adaptive control based speed control of brushless DC motors with low-resolution hall-effect sensors,” IEEE Trans. Power Electron., vol. 29, no. 3, pp. 1514–1522, Mar. 2014.
5. T. W. Chun, Q. V. Tran, H. H. Lee, and H. G. Kim, “Sensorless control of BLDC motor drive for an automotive fuel pump using a hysteresis comparator,” IEEE Trans. Power Electron., vol. 29, no. 3, pp. 1382–1391,Mar. 2014.
6. J. Moreira, “Indirect sensing for rotor flux position of permanent magnet AC motors operating in a wide speed range,” IEEE Trans. Ind. Appl., vol. 32, no. 6, pp. 1394–1401, Nov./Dec. 1996.
7. S. Ogasawara and H. Akagi, “An approach to position sensorless drive for brushless DC motors,” IEEE Trans. Ind. Appl., vol. 27, no. 3, pp. 928–933, 37
8. R. Shanmugasundram, K. M.Zakariah, and N. Yadaiah, "Digital implementation of fuzzy logic controller for wide range speed control of brushless dc motor", in Proc. IEEE Int. Conf. Veh. Electron Safety, Pune, India,
9. Sriram,J.; Sureshkumar,K, Speed control of BLDC motor using fuzzy logic controller based on sensorless technique”, Green computing communication and electrical engineering, international conference,2011.