Research on the intelligent control method of wind turbine grid connection without load

Jing Ren¹ and Shudong Wang¹

¹College of Electrical and Information Engineering, Lanzhou University of Technology, Lanzhou, Gansu, 730050, China

Abstract. Aiming at the problem that some wind turbines are difficult to achieve stability and low fitting accuracy when they are connected to the grid, an intelligent control method of wind turbine is proposed. Intelligent control is designed, and the output of the control object is the same as the expected output. The initial fuzzy control rules are obtained by the nearest neighbour clustering algorithm and the rules are optimized by the neural network. The fuzzy control and control strategy are integrated to realize the intelligent control of wind turbine with no load. Experiment results show that: compared with conventional control method, the intelligent control method of no-load grid-connection reaches a stable state sooner. The quadratic sum of fitting errors of the intelligent control method is lower than that of the conventional control method, which indicates that the intelligent control method has a higher fitting precision for samples, and the effect is better when the fan is connected to the grid without load.

1 Introduction

All aspects of human production and life involve energy use. With the development of society and economy, the demand for energy for human production and life is increasing day by day. In China's energy supply structure, coal, oil and other non-renewable energy accounts for a considerable part. The extensive use of such energy sources not only causes serious environmental pollution, but also causes exhaustion of energy resources, leading to a prominent contradiction between the development situation and environmental pollution. Therefore, we must step up efforts to develop new energy and renewable energy, relieve the pressure of non-renewable energy, optimize the overall structure of energy, and develop and utilize new energy. Various forms of energy can be transformed into each other. Wind energy is the kinetic energy of air flow. Windmills can be used to extract wind energy to push large generators to work, and the electricity generated is connected to the power system [1]. Wind power generation is the large-scale wind turbine into the grid operation, generator and power system electrical connection, power exchange. Due to the random change of wind speed in the wind turbine, the unstable current generated during grid connection due to the abnormal rotor speed will cause a large change in the grid voltage, resulting in too slow response speed for grid connection, resulting in unstable operation and more likely to damage the generator. Using intelligent control method, control interconnection of wind turbine is analyzed. Through the study of power, the control rules are stored in the rule base in the form of rule set, which

optimizes the control rules, reduces the power output ripple, improves the effect of intelligent control, and has the ability of real-time learning, so as to realize the intelligent control of no-load grid connected wind turbine.

2 Design of intelligent control method for no-load grid-connected wind turbine

The design process of no-load grid-connected intelligent control method for wind turbine includes intelligent control design, optimization of control rules and realization of three parts of intelligent control. The design process of intelligent control method is shown in figure 1.

*Corresponding author's e-mail: renjing2005cqu18@163.com

Figure 1 Design drawing of intelligent control method

Figure 2 Schematic diagram of intelligent control

The wind generator set power output P_0 , rated power for P_E , power error $e = \Delta P = P_0 - P_E$, error rate e_c as input variables, u as output variables. The exact values e and e_c were quantified as E and EC by the quantization factors K_E and K_{EC} . Let $E(t)$ $(-X_E, X_E)$ be the basic domain of the input variable E , $dE(t)/dt$ $(-X_{EC}, X_{EC})$ be the basic domain of the input variable EC , and the basic domain of the output variable u be $(-X_U, X_U)$. According to the data, the input quantization factors K_E and K_{EC} and the output scaling factor K_U have a great influence on the control effect during the control process [3].

The larger the K_E , the faster the response; The larger the K_{EC} , the slower the response speed and the better the control effect. The larger the K_U , the faster the response speed and the stronger the control effect; However, when the selected K_U is too large, it is prone to oscillation,

2.1 intelligent control design

Since no-load grid-connection has nonlinear objects with multiple inputs and outputs, in order to better control the no-load grid-connection of wind turbine units, intelligent control is used to describe the relationship between multiple variables [2], so that the output of the controlled object is the same as the expected output. Using intelligent control to adjust the power, so that the variable pitch actuator can operate at a variable speed in time. The intelligent control principle of variable propeller power is shown in figure 2.

which is not conducive to control. Therefore, the selection of K_E , K_{EC} and K_U should be appropriate [4].

The fuzzy domain subset of E is $[-6, 6]$, and the fuzzy domain subset of EC is $[-6, 6]$. Generally speaking, in order to improve the control accuracy, the number of elements in the basic domain is usually increased [5]. The basic domain of fuzzy control is divided into 13 parts, and the fuzzy domain is defined as the discrete domain of finite integers:

$N = \{-6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6\}$ The input value triangle membership function is used to determine the range of the input value according to the scope of the input variable. The fuzzy classification method is divided into 7 fuzzy sets, which are: (PB), (PM), (PS), (zero), (NS), (NM) and (NB), and the fuzzy domain comparison table is obtained, as shown in table 1.

Table 1 Table of fuzzy domain comparison

	PB	PM	PS	ZO	NS	NM	NB
-6	0	0	0	0	0	0.2	1.0
-5	0	0	0	0	0	0.7	0.8
-4	0	0	0	0	0.2	1.0	0.4
-3	0	0	0	0	0.7	0.7	0.1
-2	0	0	0	0	1.0	0.2	0
-1	0	0	0	0.5	0.9	0	0
0	0	0	0	1.0	0	0	0
1	0	0	0.9	0.5	0	0	0
2	0	0.2	1.0	0	0	0	0
3	0.1	0.7	0.7	0	0	0	0
4	0.4	1.0	0.2	0	0	0	0
5	0.8	0.7	0	0	0	0	0
6	1	0.2	0	0	0	0	0

For the fuzzy data information obtained after fuzzy processing, the computer needs to control the data information according to a series of if-then type fuzzy condition statements in the database. Fuzzy rules are usually summarized and extracted from a large number of practices. Fuzzy language variables are combined with numerical algorithm analysis, based on the manual control of parents' time experience and knowledge accumulation[6].

For dual input single output, usually:

RN: IF e is A_i and e_c is B_i then u is C_i Where, A_i , B_i , C_i , are the language values corresponding to e , e_c and u in rule I , and R_i is the control rule I .

The implied fuzzy relation is: $R_i = (A_i \times B_i) \times C_i$ Finally, for each group of input e and e_c , the corresponding output u is calculated and expressed in table form to generate a fuzzy query table and complete the intelligent control process of variable pitch.

2.2 optimize control rules

For the no-load grid-connection system of wind turbine, it is highly nonlinear and needs to optimize the control rules with the help of RBF neural network [7]. When the number of intelligent control rule sets is equal to the number of hidden layers in the RBF network, the weights in the neural network correspond to the parameters in the rule library. Using the memory characteristics of neural network to remember rules, and using the learning function of neural network to adjust the control rules to achieve the purpose of optimization. The neural network fuzzy control model is shown in figure 3.

Figure 3 Intelligent control model based on RBF neural network

Based on the fuzzy reasoning realized by the neural network structure, the generated model neural control has the function of nonlinear control and the ability of self-learning and self-adaptation of the neural network. The initial control rules are obtained through the nearest neighbor clustering algorithm, and then the parameters of the control rules are input into the neural network for parameter adjustment [8]. In the algorithm, the first data is first used as the clustering center of the first group. If the distance between a data and the clustering center is less than a certain expected value, the data is put into the group. Otherwise, set the data as the clustering center for the new cluster

2.3 realize intelligent control

The control method is realized through the controller. The intelligent control method is applied to the controller to obtain the power intelligent controller, which outputs

the expected power value and effectively controls the no-load grid-connection of the wind turbine. The generator power control is shown in figure 4.

Figure 4 Generator power control

Since the control generator variable pitch also includes other control rings, only the power intelligent control part of the research is shown. Through the intelligent controller combined with the control strategy, the variable pitch actuator is controlled. The variable pitch control strategy is shown in figure 5.

Figure 5 Variable pitch control strategy diagram

Thus, the design of intelligent control method for no-load grid-connected wind turbine is completed.

3 Conclusion

In order to solve the problem of the stability and accuracy of the wind turbine when it is connected to the grid without load, an intelligent control method is designed, which USES the characteristics of the intelligent control to adapt to the nonlinear system and combines the learning ability of the neural network to optimize the control rules, improve the self-learning ability, improve the intelligent control effect and realize the intelligent control.

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