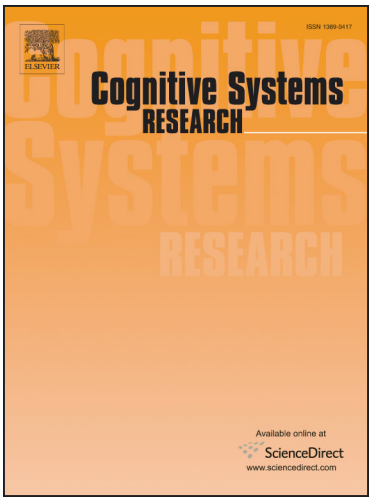

A Novel Parameter Design for level Grid-connected Smart Inverters

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[1]***Abstract*—LCL filter is an important component in the grid-connected inverters. The parameters of LCL filter have a strong influence on the output current distortion of inverters. For three-level inverter system, a parameters design method is proposed in this paper based on genetic algorithm optimization of output current total harmonic distortion (THD). By deducing the transfer function of the filter, output current THD is calculated through double Fourier analysis. Then an adaptive immune genetic algorithm is designed to solve the objective parameters optimization issue under constraint condition. With harmonics attenuation in both fundamental band and carrier band taken into account, the filter parameters are optimized scientifically by the global search algorithm, which contains punishment mechanism, adaptive parameters and the mechanism of immune algorithm. The feasibility of the proposed method is verified by conducting simulation and experiment.**

***Index Terms*—Filters, genetic algorithms, inverters, total harmonic distortion, IoT.**

I. INTRODUCTION

The three-phase voltage source grid-connected inverters [1]-[3] are widely used in many fields, such as new energy power generation, electric drive, high voltage direct current transmission, harmonic compensation and so on. Due to the use of pulse width modulation (PWM) method, large amount of harmonics are injected to the grid, affecting the electromagnetic sensitive equipment. Therefore, in order to restrain the harmonics, it is significant to design output filter of grid connected inverters.

L filter [4], LC filter [5] and LCL filter [6], [7] are commonly used filter structures. Among them, L filter is the simplest filter. However, a high switch frequency and a large inductance value that leads to a slow dynamic response are needed to achieve harmonic suppression. With an additional capacitor, LC filter improves the filtering effect of L filter. Yet the uncertainty of grid impedance directly affects the filtering performance. On the basis of the above two filters, LCL structure is proposed. Due to the advantages of low cost, small size and high frequency harmonic attenuation suppression, LCL filters are gradually applied to grid-connected converters [8], [9].

The filtering performance of the LCL filter is good for high order harmonics. However, it is a 3-order system, the frequency characteristics of which have great impact on system stability and output current distortion. Gradually parameters design for the LCL filter becomes a hot research topic [10]-[13]. Yet there are some problems in conventional LCL filter designing: 1) the optimization objective is selected as harmonic attenuation at the switching frequency, which may lead to inappropriate parameters; 2) the THD requirements are ignored and only high frequency harmonics suppression is considered.

In view of the above problems, a novel parameters design method of LCL filter based on output current THD is proposed. By deducing the grid side current THD, the parameters design issue is transformed to a target optimization one. Since the genetic algorithm [14]-[16] is a search algorithm with the capacity of global optimization, which contains population search strategy and information exchange between individuals, the genetic algorithm and immune theory [17], [18] are introduced to design the adaptive immune genetic algorithm. Compared with the conventional genetic algorithm, adaptive immune genetic algorithm exhibits its capacity to maintain the diversity of population and good convergence [19-22].

Based on the analysis of three-level SPWM modulation method with same-phase stacked carrier, the inverter output harmonic voltage expression is deduced through double Fourier transform. By calculating the fundamental voltage expression, the modulation degree is obtained, followed by the amplitude of any order harmonic voltage. With these, the filter output current THD can be expressed by the relationship between harmonic current and inverter side harmonic voltage. After the above calculation and analysis, the parameter design translates into objective optimization issue with constraint condition, which can be solved by genetic algorithm. To optimize parameters and restrain the behavior of precocity and degradation, an adaptive immune genetic algorithm is designed with punishment mechanism, adaptive parameters and immune mechanism. Then the optimum parameters are selected through the operation of crossover, mutation and vaccination. In addition, given the resonance problem, the system resistance is selected and the system