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FUZZY LOGIC CONTROLLER FOR VOLTAGE PROFILE IMPROVEMENT IN GRID CONNECTED INVERTER

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ABSTRACT

In order to address instabilities in a grid-connected inverter system, this research suggests a fuzzy controlled active damper. In order to stabilise the system, the adaptive active damper, which is coupled at the point of common coupling, controls the virtual resistance to a critical value. To control the simulation of a virtual resistor across a large frequency range, a harmonic current reference compensation approach is utilised. The three phase adaptive active damper controlled by a stationary frame, synchronous d-q frame, and decoupled synchronous d-q frame is demonstrated in this work using the harmonic current reference compensation approach. The adaptive active damper increases the stability of the grid-connected inverters during poor grid conditions by directly controlling the reactive and active power with the aid of this technique.

Keywords: grid connected inverters, current reference compensation technique, Adaptive active damper, harmonic, FIS controller, PI controller.

1. INTRODUCTION

Due to the high outage rate of distributed generation systems, the power grid looks more like a weak power grid with a large number of grid impedance values. Inverters are designed to be stable in stiff grids, but often become unstable when connected to a weak grid via a common coupling point. Traditionally, impedance-based stability criteria have been used to assess system stability. Two points are considered here. One is that the grid-connected inverter is stable under hard-grid conditions, and the other is that the relationship between the grid impedance and the output impedance of the inverter meets the Nyquist criterion to improve the stability of the grid, the control parameters should be optimized so that the output impedance is positive, or the control algorithm of the grid-connected inverter should be changed. These methods make the system robust and stable against grid impedance variations, but at the same time require changes to the grid-connected inverter's internal configuration, the power circuit, and the control algorithm, which is usually modular.

Another method is to connect an external damping resistor in parallel with the common coupling point to dampen the resonance between the grid and the grid-connected inverter. If this resistor is updated in a power electronics converter to eliminate extra power loss in the system, this resistor is called an active damper. Various types of filtered grid-tied inverters are commonly used in combination with active snubbers. Filtration includes L-type, LC-type, and LCL-type. The L type is the basic form of filtering used. A capacitor is used in series with the filter to reduce the voltage rating of the active attenuator. Furthermore, the fundamental component of the voltage at the point of common coupling is preserved. Using an LCL filtered grid-tied inverter with an active snubber provides better attenuation of harmonics present at the switching frequency compared to others and is feasible in a small size.

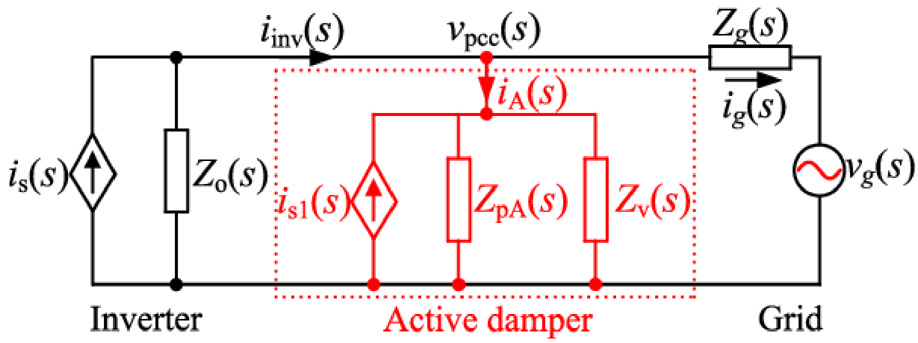

Fig.1 Active Damper System Connection

By simulating a virtual resistor during harmonic frequencies, the active damper exhibits a similar operating principle to that of a resistive active power filter and, as a result, controls the output current harmonic components so that they are proportional to the point of common coupling voltage harmonics. By injecting currents into the grid, the active damper also functions as an inverter connected to the grid. In order to attain a wide control band width and high switching frequencies, the active damper's power rating is kept lower than that of the system's grid-connected inverters.

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2. METHODOLOGY

This paper mainly deals with adaptive active damping. In this case, an external resistor is added in parallel with the common contact to dampen the resonance between the grid and the grid-connected inverter. In modern electronics, this resistor has been replaced by a power electronics converter, called an active damper. This process is called active damping. Figure 2 shows the paper's proposed model for incorporating an active damper into a grid-connected inverter under weak grid conditions. Here, an active damper is implemented using an LCL filtered grid-connected inverter.

An adaptive active damper works like a resistive active power filter simulating a virtual resistance with harmonic frequencies such that the harmonic content of the output current is proportional to the harmonic voltage at the common contact.

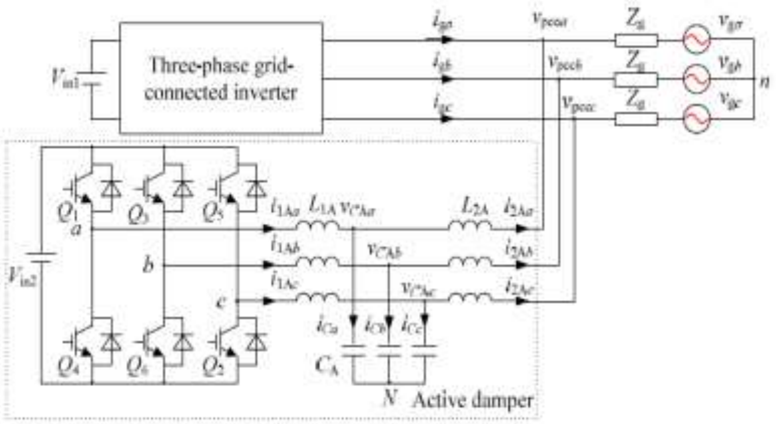

Fig. 2 Circuit Diagram of Three phase grid connected inverter with adaptive active damper

2.1 Active damper under hybrid frame

The synchronous d-q frame's direct management of active and reactive power is combined with the harmonic current reference and filter capacitor current feedback from the stationary - frame to create the hybrid frame. In essence, the adaptive active damper enhances the stability of grid-connected inverters under weak grids by automatically simulating a virtual resistor to damp the resonance at the point of common connection. It may alternatively be viewed as a grid-connected inverter of the LCL type that adds current to the grid.

2.3 Fuzzy Logic Controller

Fuzzy Logic Controller: The DC side capacitor voltage has to be measured and compared to a reference value in order to perform the control algorithm of a shunt active filter. For fuzzy processing, the error and change in error are two inputs. The control action in a fuzzy controller is decided by linguistic rule sets. The benefit is that it can function with erroneous inputs and does not require a mathematical model.

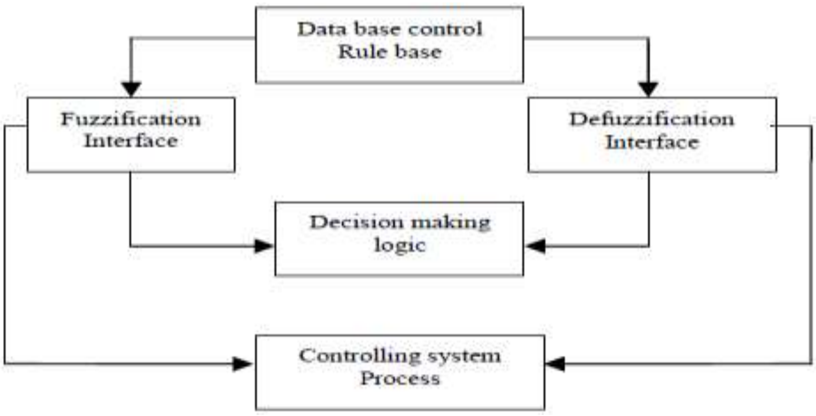

Fig.3 Fuzzy Inference System

2.4 Design of Control Rules

A. Fuzzification:

The fuzzy control rule design involves defining the rules that relate the input variables to the output model properties. Since fuzzy logic controller is independent of system model, the design is majorly based on the intuitive feeling and experience of the process. The rules are expressed in English like language with syntax such as If {error *e* is A and change of error *Δe* is B} then {control output is C}. For better control performance finer fuzzy petitioned subspaces (NL, NM, NS, ZE, PS, PM, PB) are used.

2.5 Advantages of Fuzzy Control

The advantages of fuzzy control over the adaptive control can be summed as follows:

▪ It relates output to input, without much understanding all the variables, permitting the design of system to be more accurate and stable than the conventional control system.

▪ the linguistic, not numerical; variables make the process similar to that of human thinking processThe fuzzy controller uses two input membership variables; error E and change in error dE. The fuzzy function has only one output. The function considered is 'mamdani' function with seven membership functions in each variable. The input membership functions are in gauss format and are shown in figure 4.6.

3. SIMULATION RESULTS & ANALYSIS

3.1 SIMULATION MODEL DESCRIPTIONS

The below figure depicts the proposed test system that contains a conventional source connected in parallel to the inverter fed with DC source. The grid connected inverter along with the active damper is connected to the PCC using a circuit breaker at a time point of 0.2 seconds. In this paper we are making use of MATLAB and Simulation Software for the development and analysis of an adaptive active damper for a grid connected inverter controlled with the help of PI controller and FIS controller.

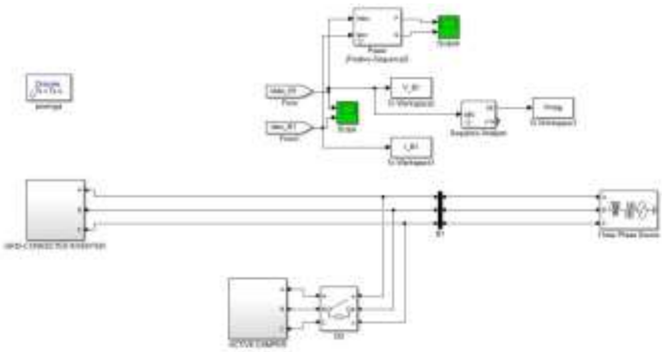

Fig.4 Proposed Test System

3.2 SIMULATION RESULT ANALYSIS

In order to obtain the simulation results of the above-described model, the simulation is been run for a time period of 1 sec. The voltage and current are recorded both with and without active damper circuit. At a time point of 0.2 sec the active damper circuit is introduced to the grid. The below figures depicts the traced graphs. .

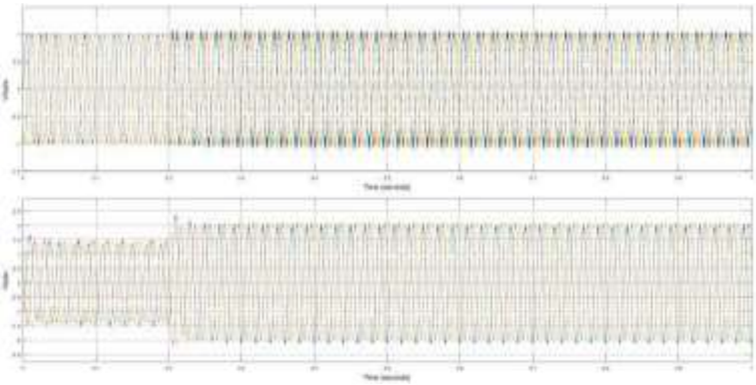

Fig.5 PCC Voltages and Currents with PI Controller

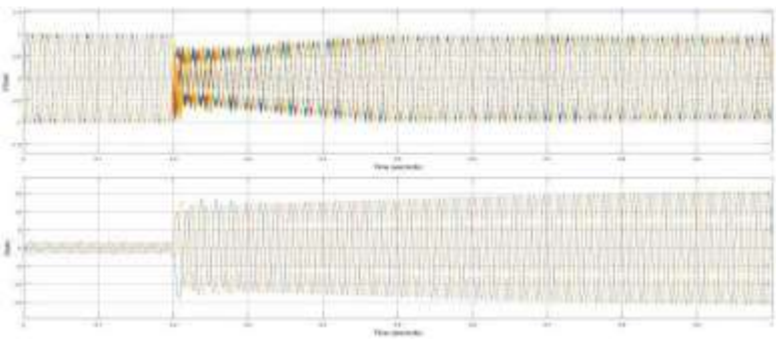

Fig.6 PCC Voltages and Currents with FIS Controller

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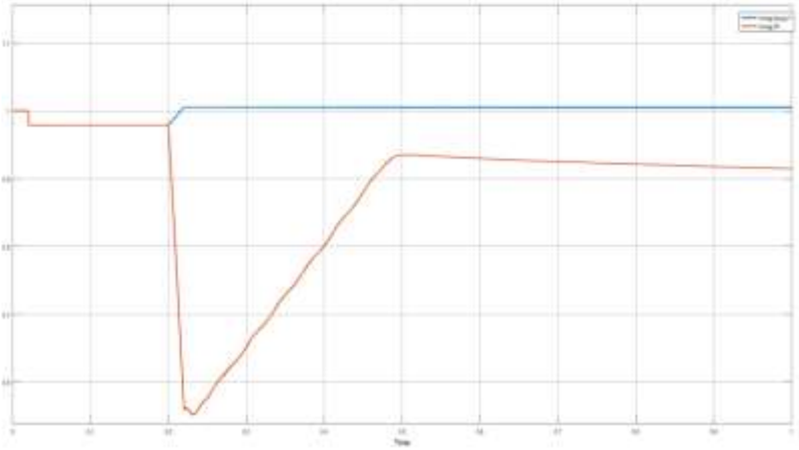

Fig.7 Comparison of Vmag at PCC with PI and FIS Controller

4. CONCLUSION

When using a FIS-controlled active damper, the voltage magnitude settles more quickly and is rather steady close to 1pu, according to the analysis of the findings above. However, there is a sluggish settling of the voltage magnitude in the case of PI controlled active dampers, which is neither steady nor close to 1 pu. The THD of the PCC voltage has been examined using an FFT analysis tool. From this, it can be concluded that when the grid system is coupled to various controller-based active damper circuits, the harmonics resulting from this are lower in the case of the FIS controller than the PI controller.

5. REFERENCES

[1] M. Liserre, R. Teodorescu, and F. Blaabjerg, “Stability of photovoltaic and wind turbine grid- connected inverters for a large set of grid impedance values,” IEEE Trans. Power Electron., vol. 21, no. 1, pp. 263–272, Jan. 2006.

[2] J. Sun, “Impedance-based stability criterion for grid-connected inverters,” IEEE Trans. Power Electron., vol. 26, no. 11, pp. 3075–3078, Nov. 2011.

[3] D. Pan, X. Ruan, C. Bao, W. Li, and X. Wang, “Optimized controller design for LCL-type grid- connected inverter to achieve high robustness against grid-impedance variation,” IEEE Trans. Ind. Electron., vol. 62, no. 3, pp. 1537–1547, Jul. 2014.

[4] L. Harnefors, L. Zhang, and M. Bongiorno, “Frequency-domain passivity based current controller design,” IET Power Electron., vol. 1, no. 4,841 pp. 455–465, Dec. 2008.

[5] L. Harnefors, A. G. Yepes, A. Vidal, and J. Doval - Gandoy, “Passivity based controller design of grid-connected VSCs for prevention of electrical resonance instability,” IEEE Trans. Ind. Electron., vol. 62, no. 2, pp. 702–845 710, Feb. 2015.

[6] J. He, Y. W. Li, D. Bosnjak, and B. Harris, “Investigation and active damping of multiple resonances in a parallel-inverter-based micro grid,” IEEE Trans. Power Electron., vol. 28, no. 1, pp. 234–246, Jan. 2013.

[7] X. Wang, F. Blaabjerg, M. Liserre, Z. Chen, J.He and Y. W. Li, “An active damper for stabilizing power electronics based ac systems,” IEEE Trans. Power Electron., vol. 29, no. 7, pp. 3318–3329, Jul.2014.

[8] X. Wang, Y. Pang, P. C. Loh, and F. Blaabjerg, “A series-LC-filtered active damper with grid disturbance rejection for ac power- electronics based power systems,” IEEE Trans. Power Electron., vol. 30, no. 8, pp. 4037-4041, Aug. 2015.

[9] H. Bai, X. Wang, P. C. Loh, and F. Blaabjerg, “Passivity enhancement of grid-tied converters by series LC-filtered active damper,” IEEE Trans. Ind. Electron., vol. 64, no. 1, pp. 369–379, Jan.2017

[10] L. Jia, X. Ruan, W. Zhao, Z. Lin and X. Wang. “An Adaptive Active Damper for Improving the Stability of Grid-Connected Inverters Under Weak Grid,” IEEE Trans. Power Electron., accepted.

[11] P. A. Dahono, “A control method to damp oscillation in the input LC filter of AC-DC PWM converters,” in Proc. IEEE PESC, Cairns, Australia, 2002, pp. 1630–1635.

[12] W. Li, X. Ruan, D. Pan, and X. Wang, “Full- Feed forward Schemes of Grid Voltages for a Three-Phase LCL-Type Grid-Connected Inverter,” IEEE Trans. Ind. Electron., vol. 60, no. 6, pp. 2237–2250. Jun. 2013.

[13] E. Twining and D. G. Holmes, “Grid current regulation of a three-phase voltage source inverter with an LCL input filter,” IEEE Trans. Power Electron., vol. 18, no. 3, pp. 888–895, May 2003.