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Fuzzy controlled universal active power filter interconnected PVA with adaptive filter

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ABSTRACT

In this paper a novel technique based on adaptive filtering is proposed for the control of three phase universal active power filter with solar photovoltaic array integrated at its DC bus. two adaptive filter along with a zero-crossing detection technique are used to extract the magnitude of fundamental active component of distorted load currents, which is then used in estimation of reference signal for the shunt active filter. This technique enables extraction of active component of all three phases with reduced mathematical computation. The series active filter control is based on synchronous reference frame theory and it regulates load voltage and maintains it in-phase with voltage at point of common coupling under conditions of voltage sag and swell. A universal active power filter is connected to a test system for harmonics mitigation generated by non-linear load connected to three phase grid. The universal active power filter has two VSCs connected in series and parallel to the grid PCC. The two VSCs are connected to common PVA along with DC link capacitor the harmonic distortion comparison is done on source current using FFT analysis with PI and fuzzy logic controller.

Keywords: VSC (Voltage Source Converter), PCC (Point of Common Coupling), PVA (Photo Voltaic Array), FFT (Fast Fourier Transformation). Universal active power filter, adaptive filtering, photovoltaic system, maximum power point tracking, quadrature signal generation.

INTRODUCTION

Due to increase in the demand of clean energy system based on solar and wind energy in the present distribution system. In this technique the model is based on adaptive filter is proposed for the control of three phase universal active power filter integrated DC Bus with solar PV array. Two adaptive filter with zero crossing detection technique are used to extract the magnitude of fundamental active component of the load distortion.

There's intermediate nature of voltage fluctuation has become a major issue in low voltage distribution system network [1]. In the modern era with development of semiconductor devices the use of sophisticated power electronic devices is gradually increased. Just like computed power supplies, variable frequency drives (VFD), switched mode power supply (SMPS), servers. Although all the electronic devices are less power, so called energy efficient but they draw nonlinear current from the supply. Due to this there's increased in sensitivity of disturbance. This non-linear current also effect the distribution transformer and common point coupling system (PCC)[2],[3].Here one things been cleared that "the clean energy with best power quality are not demand of the upcoming future". It also reduced the dependency son fossil fuels for energy. That's may cause improvement of environment [4]. The renewable energy are being connected along with

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the flexible AC transmission systems (FACTS) for unified power flow control (UPFC) are being discussed in [5],[6]. FACTS devices such as UPFC are used in transmission system along with large PV farms to improve the power system stability.

II.PROPOSED METHODLOGY

2.1Introduction

In the proposed model a novel technique are used whose working based on adaptive filter for the control of three phase universal active power filter of DC bus integrated with solar PV array. To extract the fundamental active component of the distorted load current magnitude the zero-crossing technique are being used. Further it is used to estimate the reference signal for the shunt active filter. It will extract the active component of all three phase. The series active power filter are uses here to regulate the load voltage and maintain it in phase are based on synchronous reference frame theory.

A test system are taken and connected it to the universal active power filter for harmonics mitigation generated by non-linear load connected on three phase grid. The universal active power filter are consist of two VSC that is connected in series and parallel to the PCC grid. Further it connected with DC link capacitor. Power electronics switches are used with fuzzy controlled interface system. The fuzzy interface system has two input variables and one output variables being replaced by PI controller at DC voltage regulator. The total harmonic distortion are done comparison on source current using FET analysis. The modeling is done on MATLAB Simulink environmental with power gui tool box. The given figure 1.a shows the configuration of a PV-UPAF system inside this configuration of three phase system consisting of shunt filter as well as series filter along with a common DC bus system. The series active filter are connected in series with PCC, where shunt active filter are connected across the non-linear load. Interface inductor, ripple filter and injection transformer are major component connected inside the system. PV array is directly connected to the PVUPAF system of DC bus.

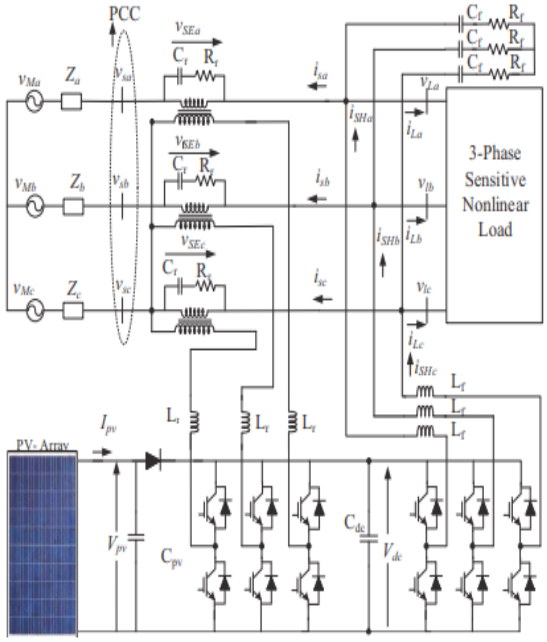

Fig. 2.1: Proposed system of Solar Photovoltaic Integrated Unified Active Power Filter

2.2PROPORTIONAL-INTEGRAL CONTROL SYSTEM

Proportional-integral-derivative controllers find wide application in industrial control systems due to the reduced number of parameters to be tuned. They also provide control signals that are proportional to the error between the reference signal and the actual output i.e. proportional action, to the integral of the error i.e. integral action and to the derivative of the error i.e. derivative action [13]. The consequent equation is given as:

$$u(t) = K_p e(t) + K_i \int_0^t e(t)dt + K_d \frac{d}{dt} e(t) \qquad (2.1)$$

2.3 FUZZY LOGIC CONTROLLER

Fuzzy logic or fuzzy set theory was given by Lotfi Zadeh, a computer scientist at the University of California, Berkeley, in 1965, for representing and manipulating data that is not precise and rather fuzzy or vague. In the beginning he was criticized

by the professional community, but progressively, Fuzzy logic (FL) gained importance in the professional society and in due course emerged as a new order of Artificial Intelligence. The FL became a attractive area of research because it worked really well between significance and precision, that for a very long time humans have been doing manually.
The FL provides an inference that facilitates approximate human reasoning capabilities to be applied to knowledge-based systems.

2.4 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 process.

III.SIMULATION RESULT AND DISCUSSION
The complete design related to the project is created in MATLAB & Simulation using Sim Power System Toolbox and. This designing is conducted in two stages:
1.To Control of Solar Photovoltaic Integrated Universal Active Filter Based on Discrete Adaptive Filter with using PIcontroller.
2.Control of Solar Photovoltaic Integrated Universal Active Filter Based on Discrete Adaptive Filter with using fuzzycontroller.

Case 1: To Control of Solar Photovoltaic Integrated Universal Active Filter Based on Discrete Adaptive Filter with using PI controller.

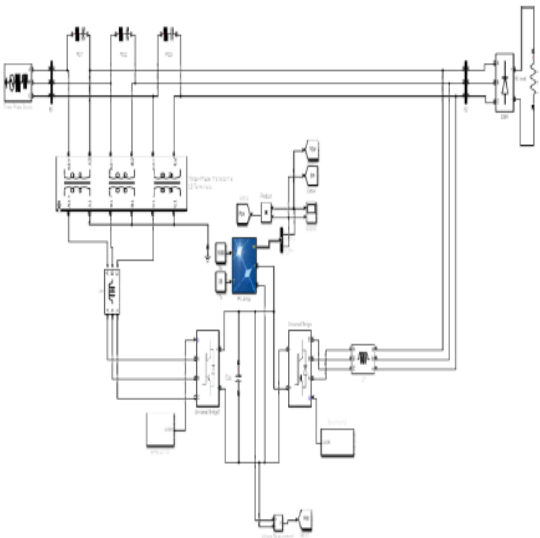

Fig 3.1: Proposed PVA integrated UAPF connected and using PI controller.

In fig. no. 3.1 the system with non-linear load connected to three phase sources with universal active power filter integrated with PVA at DC link.

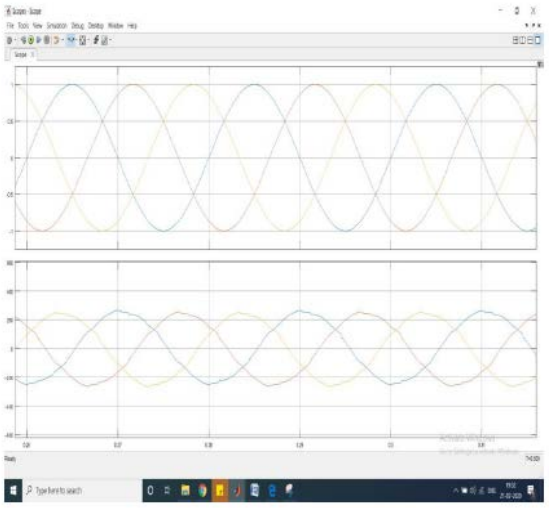

Fig. 3.2: Source voltages and currents with PI controlled PVA UAPF.

Case 2 Control of Solar Photovoltaic Integrated Universal Active Filter Based on Discrete Adaptive Filter with using fuzzy controller.

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The shunt active power filter control is updated with fuzzy controller replacing PI controller

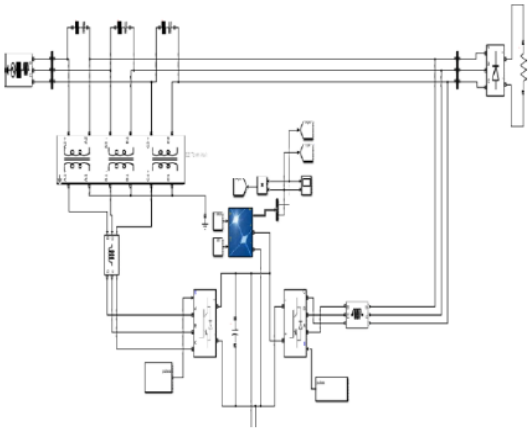

Fig 3.3: Proposed PVA integrated UAPF connected and using fuzzy controller.

The PVA voltage is constant at 350V. The below is the DC link voltage measured across DC link capacitor maintained at 350V.

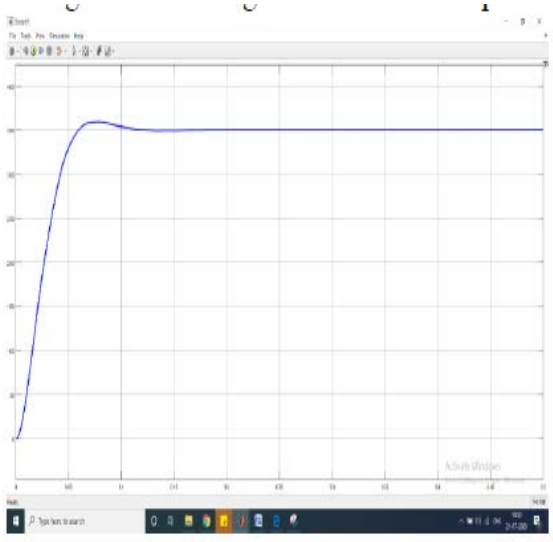

Fig. 3.4: DC voltage across DC link capacitor

IV FFT ANALYYSIS

FFT analysis of source voltage is done to get THD of the signals. The analysis is carried out on all models, no UAPF, with UAPF controlled by PI controller, with UAPF controlled by fuzzy controller.

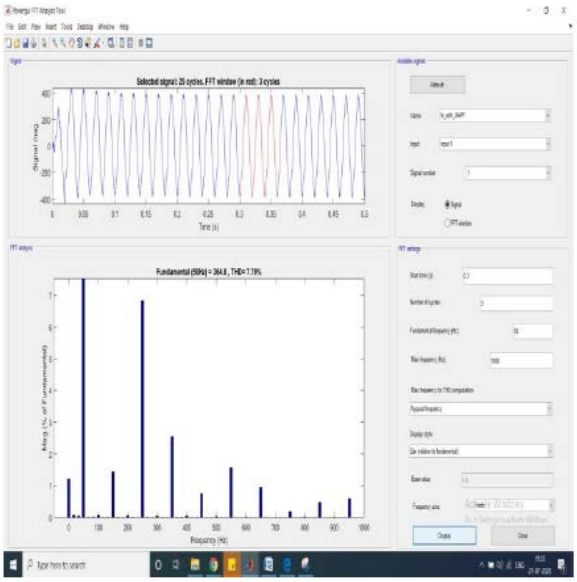

Fig. 4.1: THD of source voltage with PI controlled PVA UAPF.

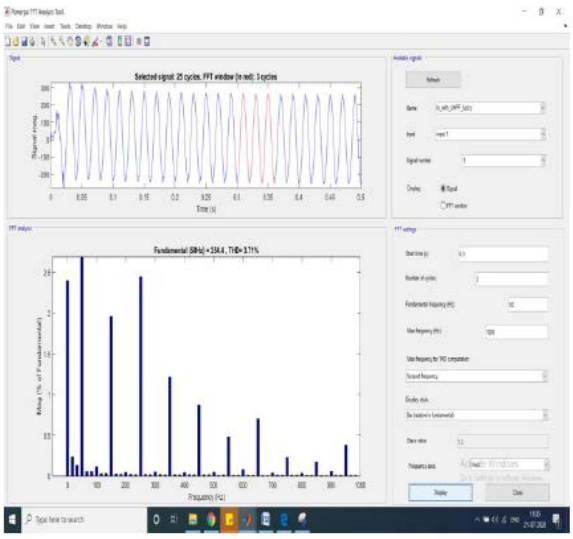

Fig. 4.2: THD of source voltage with fuzzy controlled PVA UAPF.

As observed from the FFT analysis of all models, fuzzy interface system controlled UAPF has very less THD as compared to PI controlled UAPF model.

IV.CONCLUSION AND FUTURE SCOPE

With the above results of the proposed system in all conditions, the model with PVA integrated UAPF controlled by fuzzy interface system control has very less harmonics as compared to other models. The THD comparison of source current are taken for no UAPF recorded at 29.85%, with PVA-UAPF connected with PI controller recorded at 7.79% and with PVA-UAPF connected with fuzzy controller recorded at 3.71%. Along with the comparison all the characteristics of the modules connected to the test system are also shown with respect time. All the graphs are generated with respect to using power gui toolbox in Simulink environment.

4.2 Future Scope

The above model can be updated with other renewable source like wind farm, fuel cell etc. The controllers can be updated with adaptive control techniques and sliding mode controllers. The same PVA-UAFP can be interconnected to multi-bus system with multiple sources and loads. The system is used for the variable load with being disturbance regarding the harmonics distortion. It may also be applicable in the recent era of distributive generation where the generation of electricity are done by various different source

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