POWER QUALITY IMPROVEMENT USING EUCLIDEAN DIRECTION SEARCH BASED DISTRIBUTION STATIC COMPENSATION WITH FUZZY LOGIC CONTROLLER

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Abstract
In order to address many PQ (Power Quality) problems, including harmonics, reactive power, load unbalance, and neutral current, this study suggests the construction and control of a three phase, four wire DSTATCOM (Distribution Static Compensator). As a DSTATCOM, a three-phase VSC (Voltage Source Converter) and zigzag transformer-based arrangement are used. By creating an appropriate control for VSC, additional power quality issues are reduced and the zigzag transformer is controlled to provide a suitable channel for load neutral current. Adaptive control theory is used to build the control of VSC utilising the EDS (Euclidean Direction Search) technique. This control technique creates switching pulses for VSC by separating the fundamental components from the load current. The improved behavior of proposed EDS based control is observed by comparing it with other existing controllers. Adaptive Fuzzy controller will be designed to reduce the harmonics in the current. The work will be carried out using Matlab simulink software.

Keywords : Voltage Source Converter, PI controller, Fuzzy controller. Euclidean Direction Search

1. Introduction

High levels of harmonics have been introduced into the electrical supply system as a result of the growing reliance on power electronics-based devices at the usage level. The electrical supply system is contaminated by the large number of consumer electronics that operate as nonlinear loads and draw nonsinusoidal currents. At the PCC (Point of Common Coupling), which is coupled to other loads, power quality problems become evident. The functionality of connected loads and their lifespan are impacted by problems including voltage harmonics, surge, sag/dip, swell, and others. Harmonics, reactive power, imbalanced currents, and neutral current are further issues with input currents drawn from mains [1]

2. Related Work

The literature mostly reports on the three-phase three wire (TPTW) and three-phase four wire (TPFW) configurations of DSTATCOM [3]. For managing load reactive power and removing harmonic current at the distribution system, use three-phase three-wire DSTATCOM. The TPFW shunt active compensator is used to reduce supply current harmonics, neutral current, and unbalanced load currents as well as to compensate for reactive power. The literature reports various shunt compensator topologies for neutral current reduction with additional compensating features. A select few of them are based on the four-leg voltage source converter (VSC), the three-leg VSC (split capacitors), the three-leg VSC with star/delta transformers, the three-leg VSC with zigzag transformers, and the three-leg VSC with T connected transformer [4]. Because it necessitates a three leg VSC, a common design that can be easily controlled with a low cost controller, the three-leg VSC with zigzag transformer type topology is selected [5]. The estimation of the fundamental currents (from distorted load currents) and control pulses for IGBTs (Insulated Gate Bipolar Transistors) of VSC utilised as a DSTATCOM are described using a variety of control methodologies. In addition to synchronous reference frame (SRF) [6], Icos [7],

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Lyapunov stability theory [8], moving average filter [9], model predictive control [10], modulated carrier control employing on-time doubler [11], Chebyshev function operated ANN controller [12], and adaptive Volterra second-order filter (AVSF).

Power quality is the collection of electrical attributes that must be within a certain range in order for electrical systems to operate as intended without suffering major performance or life losses. The phrase refers to both the electric power utilised to drive an electrical load and the load's capacity to operate effectively under certain conditions. An electrical equipment (or load) may malfunction, fail early, or not perform at all without the correct electricity. There are numerous ways that electric power might be of poor quality, as well as numerous more reasons of such electricity. Electricity generation (AC power), transmission, and distribution to an electricity metre situated at the premises of the end consumer of the electric power make up the electric power industry.

3. Developed a Three Phase, Four Wire Shunt Compensator

Figure 1 shows the equivalent schematic for a four wire compensator with a zigzag transformer. This system creates compensating currents that are necessary to address PQ issues such harmonics, excessive reactive power, unbalance, and load neutral current.

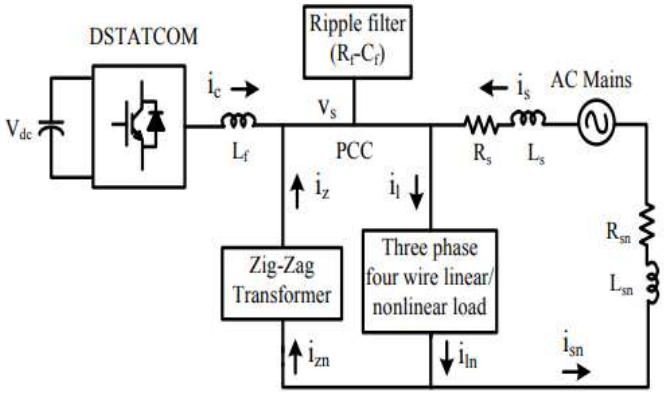

Figure1. D-Statcom

Control Circuit

Figure 2 depicts the block diagram of an EDS (Euclidean Direction Search)-based control system for a shunt compensator. This control is used to acquire the basic elements of the load currents using unit templates that are in phase with the PCC voltage

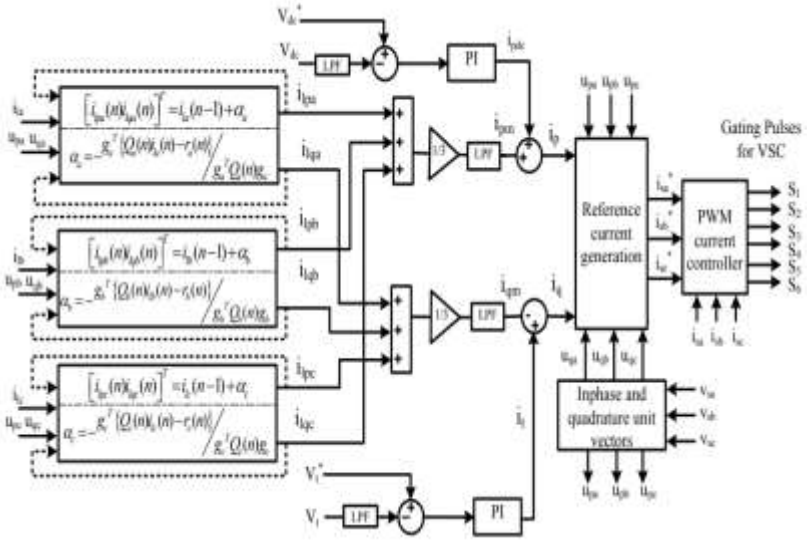

Figure2. Euclidean Direction Search method

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Fuzzy System

Fuzzy logic is a method of processing variables that enables the processing of several potential truth values through a single variable. Fuzzy logic makes an effort to resolve issues using an open, imperfect spectrum of facts and heuristics that enables the production of a variety of exact conclusions.

Fuzzy interface system A fuzzy system is essentially a fuzzy logic formulation that maps an input set to an output set. The mapping procedure forms the basis for any interference or conclusion. The following steps make up a fuzzy interface procedure:

1. The initial phase is fuzzifying the input variables.
2. The second step is applying a fuzzy operator.

The operators are used in the IF (antecedent) section of the rule (AND, OR, NOT).

3. Extrapolating from the previous step to the next (Then part of the rule).
4. The fourth step is to add up the effects of all the rules.
5. Five is defuzzification.

A rule matrix similar to the ES rule matrix will typically be provided. For instance: 7MF are available.

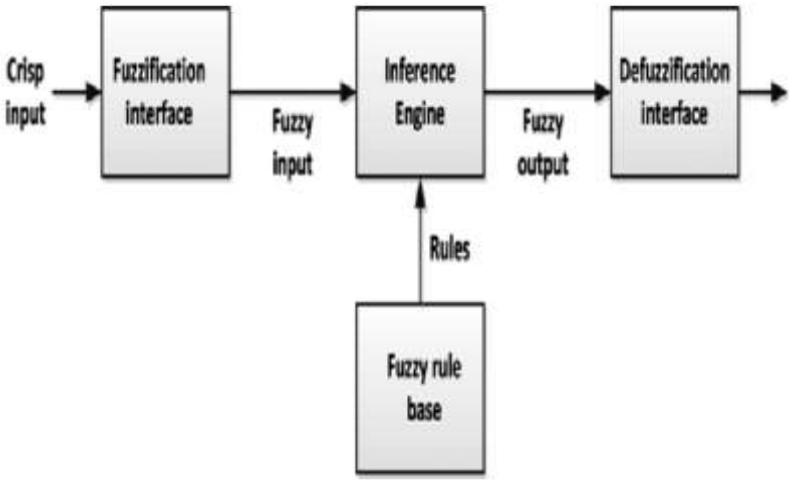

Figure3. Fuzzy controller

4. Simulation Results

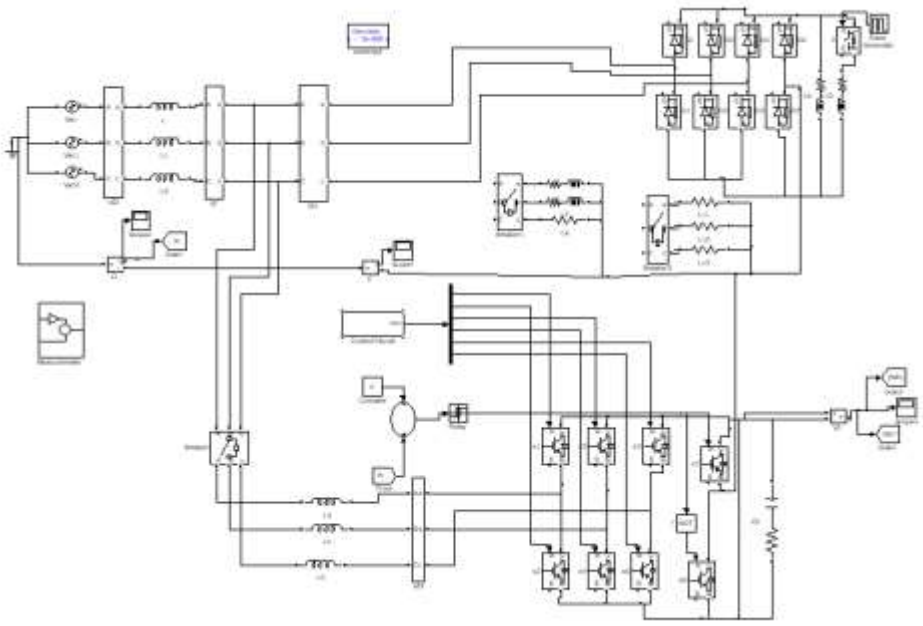

Figure.4 Distribution network with D-Statcom

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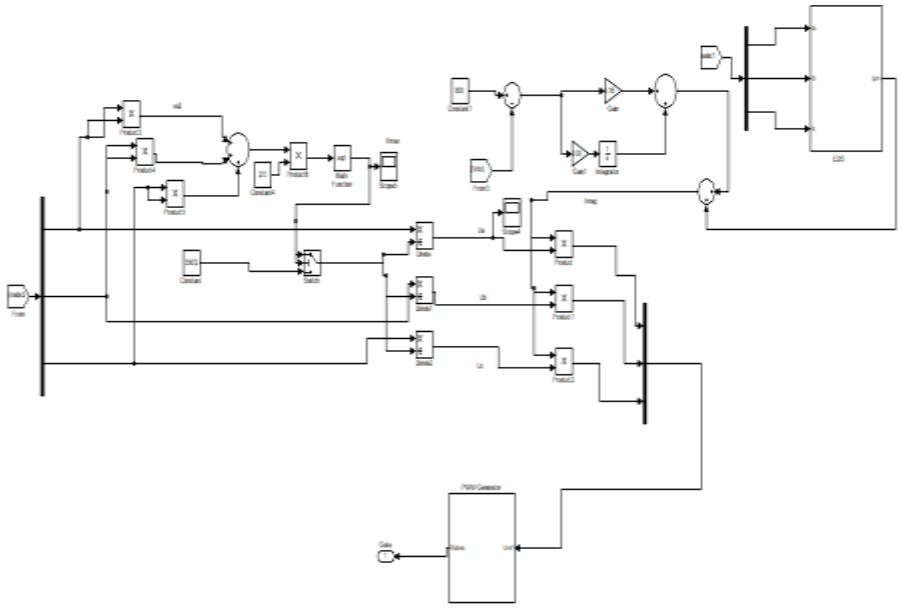

Figure5. Active filter control using EDS method

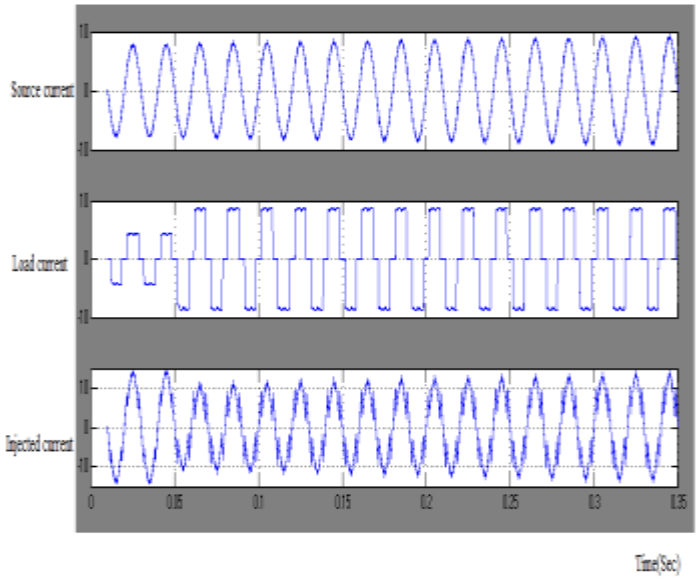

Figure6. Harmonic reduction using EDS based PI controller

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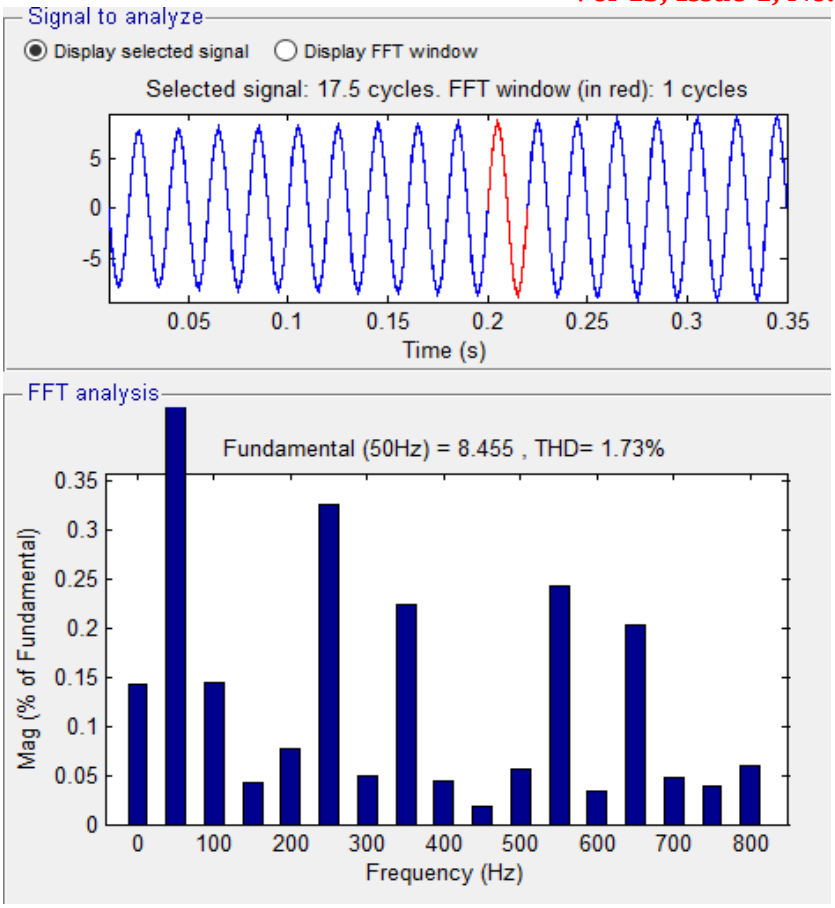

Figure7. THD using EDS-PI Controller

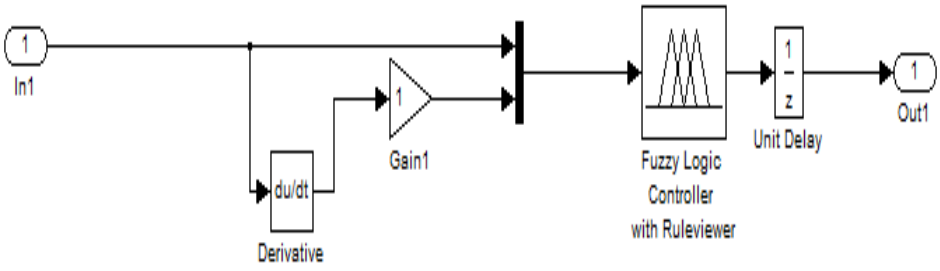

Figure8. FUZZY controller

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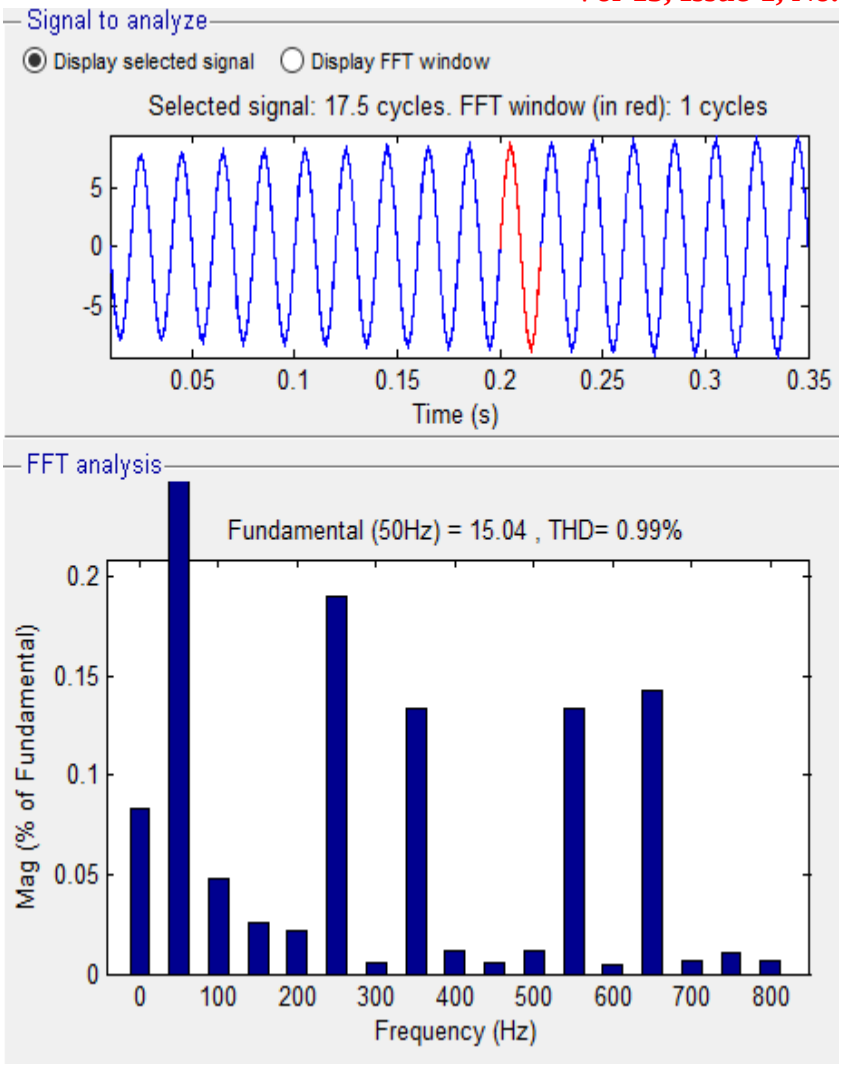

Figure8. THD with EDS-FUZZY controller

Table1. Comparison results of different controllers

	EDS-PI Controller	EDS-FUZZY controller
THD	1.73%	0.99%

5. Conclusion

The three leg VSC and a zigzag transformer were used to create a distribution static shunt compensator. The suggested method has been developed to address PQ concerns in distribution networks, including harmonics, excessive reactive power, load unbalancing, and neutral current. A zigzag transformer was used to compensate for the neutral current. In order to compute reference grid currents, a suitable adaptive control based on the EDS method has been created. PI and FUZZY controllers have been used to build the EDS control algorithm. In both situations, the total harmonic distortion (THD) is compared. Total harmonic distortion while using EDS-PI controller is 1.76%, but total harmonic distortion when using EDS-FUZZY controller is 0.99%. Better outcomes are obtained using D-Statcom on an EDS-FUZZY controller. Unified power quality conditioner can be developed using EDS method to control voltage and current.

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