Enhancing Power Quality through ANFIS-Controlled D-STATCOM

Pulivarthi Harshavardhan[1], Yenibera Sathish[2], Shaik Gousia Anjum[3], upputholla soujanyasri[4]

[1]B.Tech student, Department of EEE, RVR&JCCE Guntur, AP, India

[2]B.Tech student, Department of EEE, RVR&JCCE Guntur, AP, India

[3]B.Tech student, Department of EEE, RVR&JCCE Guntur, AP, India

[4]B.Tech student, Department of EEE, RVR&JCCE Guntur, AP, India

ABSTRACT

In this project,we propose a novel approach to enhance power quality utilizing Adaptive Neuro-Fuzzy Inference System (ANFIS) controller in Distribution Static Synchronous Compensator (D-STATCOM) systems. The integration of ANFIS with D-STATCOM offers robustness and adaptability in mitigating power quality issues such as voltage sags, harmonics, and improvement of THD of source current , load current, load voltage and also maintains DC link Voltage profile. Through comprehensive simulations and experimental validations, we demonstrate the effectiveness of the proposed ANFIS controller in improving power quality parameters, thereby ensuring stable and reliable operation of the distribution system for mitigation of voltage sag,The simulation results are evaluate by using MATLAB/SIMULINK SOFTWARE. The simulation result under normal and change in load conditions has been studied without and with D-STATCOM.

Keywords: Custom power Device, D-STATCOM, Fuzzy logic controller, Proportional Integral. ANFIS controller.

1. INTRODUCTION

In distribution systems, power quality problems arise mainly due to different non-linear loads and unplanned expansion of distribution systems. Various power quality problems comprise harmonic currents, unbalanced load, high reactive power burden. The application of power electronics technology used in power distribution led to design of new devices known as custom power devices (CD).D-STATCOM is a shunt connected custom power device which is used to takes care of such type of problems in distribution systems.

The CSC topology based DSTATCOM is used .The capacitor filter is used to AC side of D-STATCOM for improving the quality of output currents waveforms but it increase the cost of converter. It resonates with AC side inductance due to which some of harmonic present in output current might be amplified[10]when D-STATCOM is operated with sinusoidal pulse modulation technique(SPWM) the magnitude of harmonic component is proportional to fundamental component of their output.

The current injected under normal operating conditions by CSC based D-STATCOM is small percentage of line current, due to which current harmonics are small. Hence requirement of energy storage for CSC based topology is lesser when used for mitigation of voltage sag. D-STATCOM can be used to prevent the rest of distribution system from polluting non linear loads. It can be used to offer continuous and dynamic control of power supply, reactive power compensation, eliminations of harmonics ,and mitigation of voltage sag/swell.

Through investigation and performance analysis of CSC based D-STATCOM for mitigation of voltage sag which is the one of the power quality problems resulted from sudden change in load conditions connected to a distribution system. The output voltage magnitude of inverter circuit used in CP device is proportional to their DC link voltage. Hence, it is essential to maintain DC link voltage at the time of designing of CSC based Custom power Device. An effort has also been made to keep DC link voltage by using FLC in control system of D-STATCOM.

2. BLOCK DIAGRAM

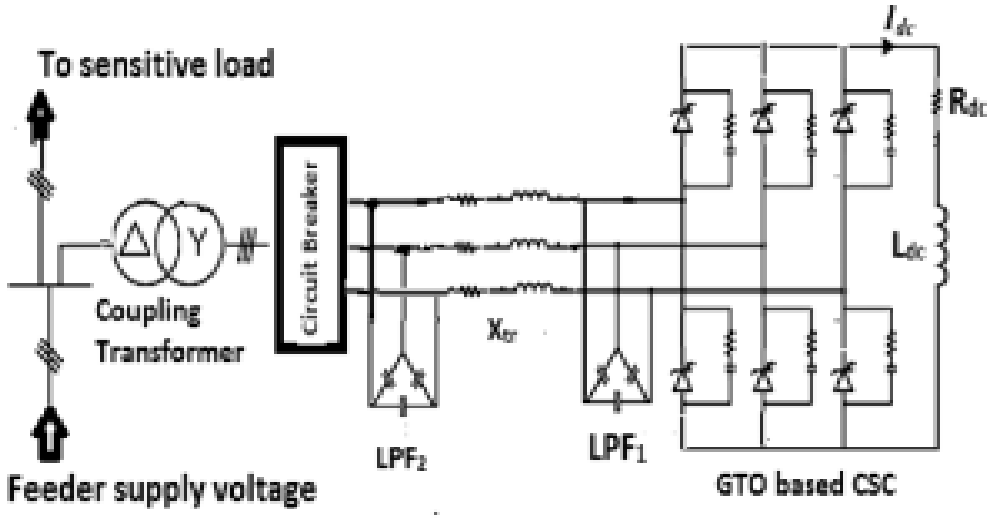

Fig: Block diagram of the proposed system

3. ADVANTAGES:.

Adaptive Control: ANFIS enables the DSTATCOM to adapt its control parameters based on real-time system conditions, ensuring optimal performance under varying load and grid conditions.

Precision:ANFIS-based control allows for precise adjustment of DSTATCOM operation, enabling targeted compensation for specific power quality issues such as voltage sag, swell, harmonics, and reactive power imbalance.

Fast Response: ANFIS controllers can provide rapid response times, allowing the DSTATCOM to quickly counteract disturbances in the power system and maintain stable voltage and frequency levels.

Efficiency: By dynamically adjusting control parameters, ANFIS optimization can enhance the efficiency of DSTATCOM operation, reducing losses and improving overall system performance.

Flexibility: ANFIS-based control offers flexibility in adapting to different operating conditions and system configurations, making it suitable for a wide range of power quality enhancement applications.

Enhancement of power quality can be possible.

Voltage sag can be mitigated.

System performance can be improved.

4. APPLICATIONS:

Distribution systems: Using an Adaptive Neuro-Fuzzy Inference System (ANFIS) controller in conjunction with a Distribution Static Synchronous Compensator (D-STATCOM) application is an advanced method for improving power quality. ANFIS helps optimize the control strategy of the D-STATCOM, enhancing its performance in mitigating voltage fluctuations, harmonics, and reactive power issues in the power system. This approach can lead to more efficient and reliable operation of the electrical grid.

5. SIMULATION DIAGRAM:

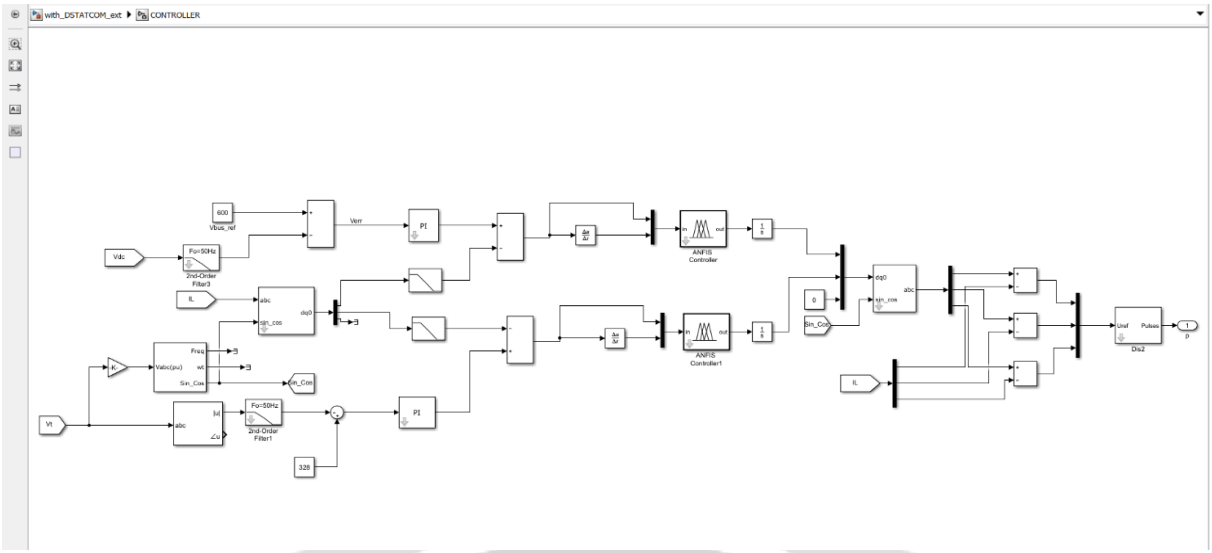

FIG: ANFIS CONTROLLER

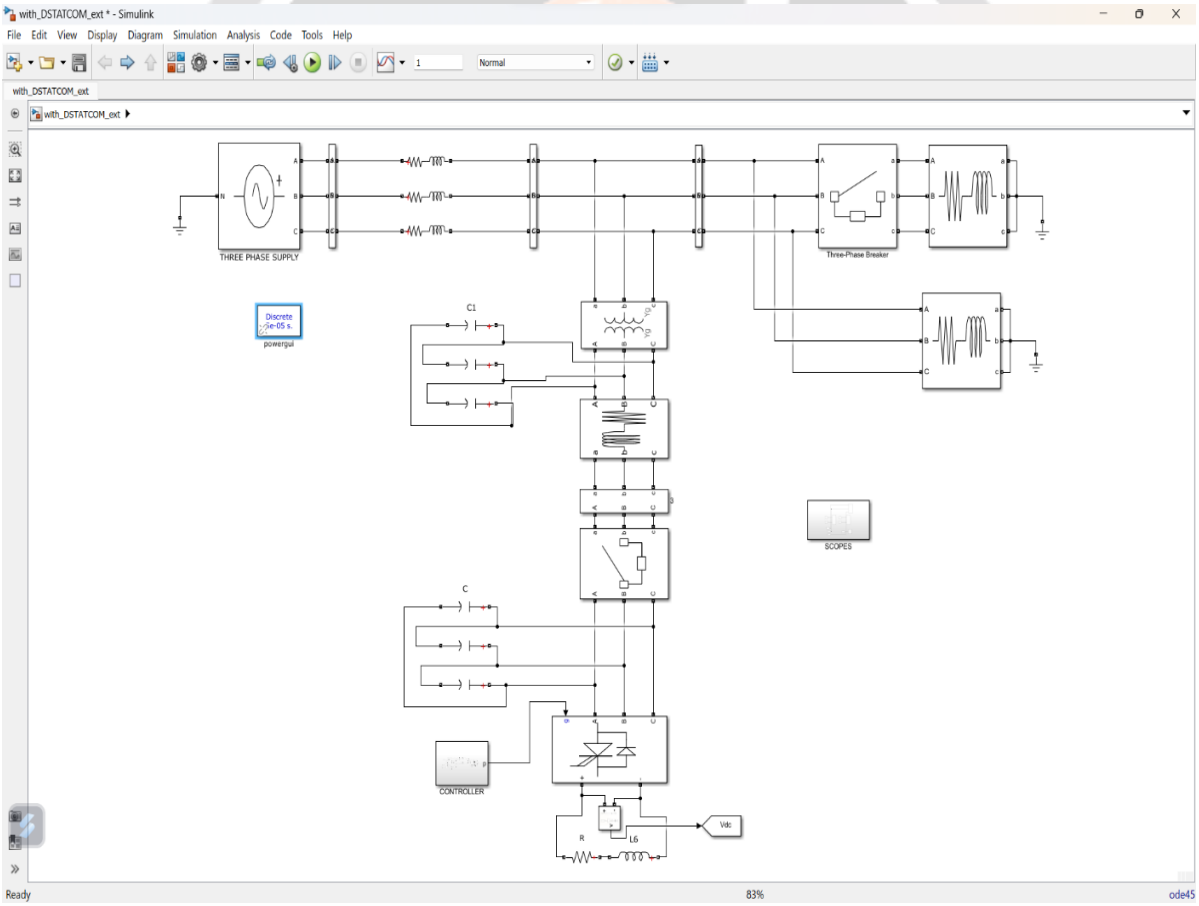

FIG: SIMULATION DIAGRAM

6. RESULTS:

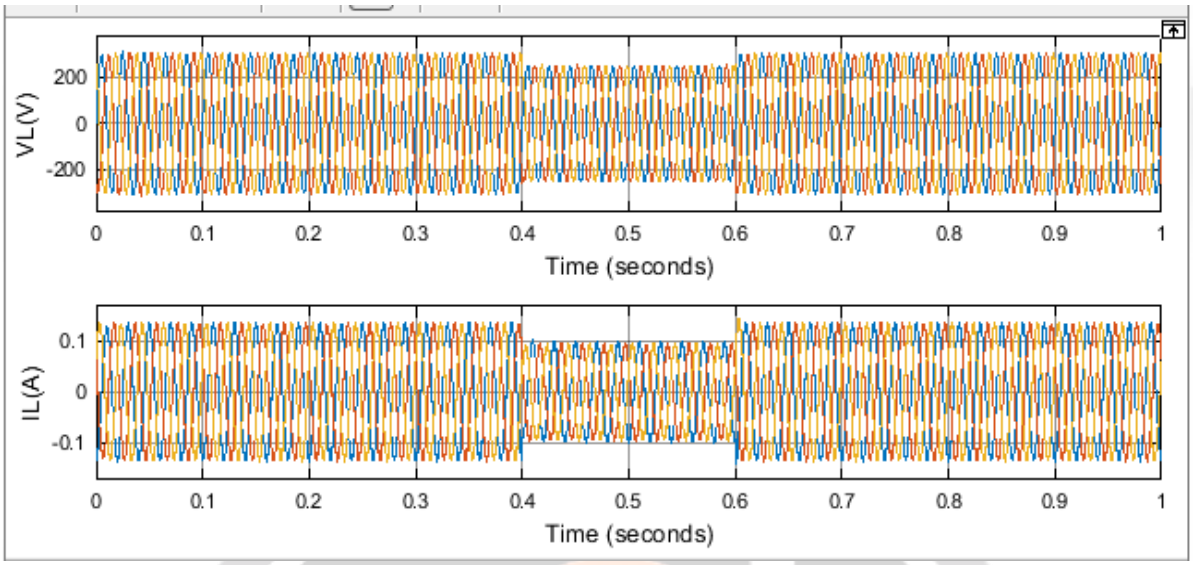

Fig: Load voltage and load current wave forms without D-STATCOM under certain change in load conditions

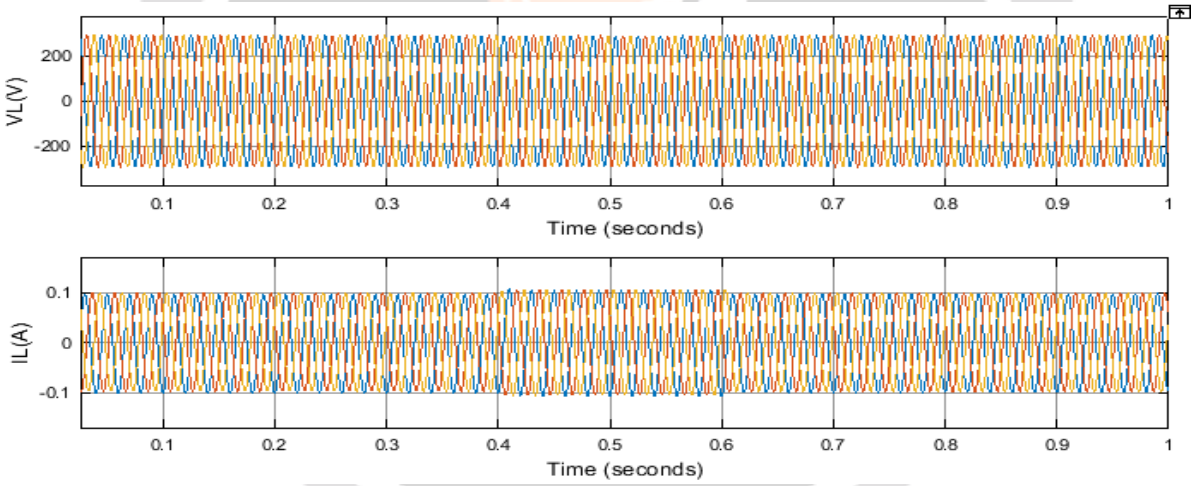

Fig: Load voltage and load current waveforms with D-STATCOM under certain change in load conditions

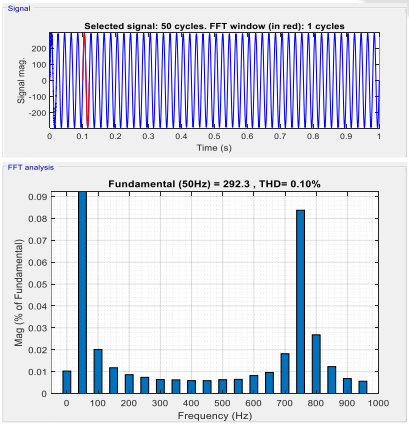

FIG: THD OF LOAD VOLTAGE

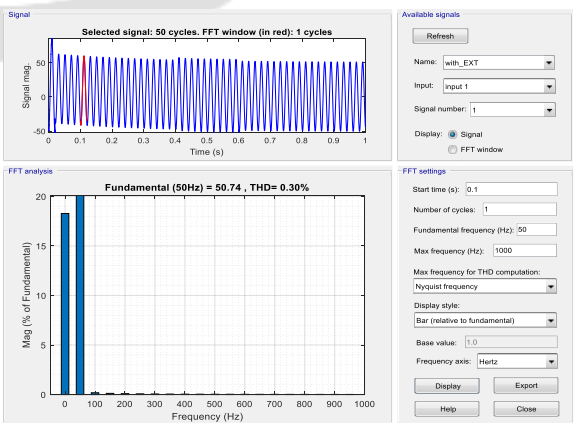

FIG: THD OF CURRENT

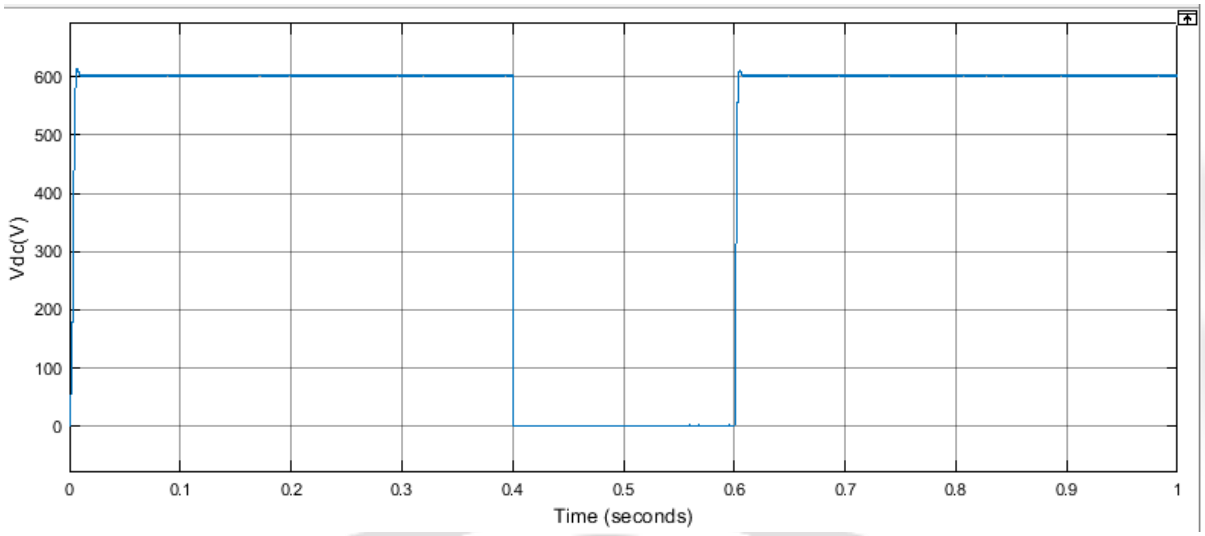

Fig: DC link rector voltage with ANFIS controller

7. CONCLUSION:

This paper presents the proposed ANFIS controller for CSC based D-STATCOM used for mitigation of voltage sag, improvement of voltage and current harmonics and to improve DC link voltage maintain DC-Link voltage profile under change in load condition in a distribution system. The voltage sag is created by switching large inductive load in distribution system for duration from 0.4 to 0.6 seconds. The load voltage shows sag during this time duration. This voltage sag is effectively mitigated by using a CSC based DSTATCOM during sudden change in load condition. THD of source current, load voltage and load current is also improved effectively and DC- link voltage becomes constant after the disturbance of load variation thus minimizing the ripple injected into distribution system by D-STATCOM.

8. REFERENCES:

[1] IEEE, "IEEE recommended practices and requirements for harmonics control in electric power systems," IEEE Std. 519, 1992.

[2] Ghosh, A., and Ledwich, G., Power Quality Enhancement Using Custom Power Devices, London: Kluwer Academic Publishers, 2002.

[3] Acha, E., Agelids, V. G., Anaya-Lara, O., and Miller, T. J. E., Power Electronic Control in Electric Systems, 1st ed., Oxford, UK: Newness Power Engineering Series, 2002.

[4] Dugan, R. C., McGranaghan,M. F., and Beaty, H.W., Electric Power Systems Quality, 2nd ed., New York: McGraw Hill, 2006.

[5] Akagi, H., Watanabe, E. H., and Aredes, M., Instantaneous Power Theory and Applications to Power Conditioning, NJ: John Wiley & Sons, 2007.

[6] Padiyar, K. R., FACTS Controllers in Transmission and Distribution, New Delhi: New Age International, 2007.

[7] Moreno-Munoz, A., Power Quality: Mitigation Technologies in a Distributed Environment, London: Springer-Verlag London Limited, 2007.

[8] Fuchs, E. F., and Mausoum, M. A. S., Power Quality in Power Systems and Electrical Machines, London: Elsevier Academic Press, 2008.

[9] Hingorani, N. G., &Gyugyi, L. (2013). Understanding FACTS:Concepts& technology of flexible AC transmission systems.London: Wiley.