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RESEARCH ARTICLE

Mitigation of Voltage Sag and Swell in Smart Grid by using Ant-Lion Intelligent Controller

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ABSTRACT

In the operational condition of an electrical power system, the need for proper utilization with quality of utilization is primal. Where different types of quality measures are deployed such as the linear filters and adaptive filters to condition the current quality, a power flow controller is deployed to compensate for the dissipation losses or fault tolerance. Where efforts are made in enhancing power quality, efforts are also made in the utilization of it. With the rapid and ever-increasing demand for power supply and rapid increases in industrial and urbanization, the demand has exceeded the supply capacity of all generation systems. To compensate for the demanded power requirement, in addition to the existing power generation units, additional subunits are added to the power system to compensate for the demanded supply. Smart grids are designed as a cluster of various generation units and consumption units. The demanded power is processed in these smart grids and using a processing algorithm, these grids play a crucial part in adjusting the power supply allocation to compensate for it. Here, the grid systems are either designed for a concentric parameter or multi-objective monitoring in making a decision. The issue is with the complexity in the parameter validation, where multi-objective monitoring gives the benefit of accurate scheduling, the complexity in parameter monitoring is higher.The main objective of the proposed is weight-defined parameter monitoring of power scheduling in multi-parameter monitoring, where the past approach of a preference-based scheduler is to be developed with different intelligent controller techniques like UNITED POWER FLOW CONTROLLER (UPFC) with ANT-LION optimization (ALO) algorithm is proposed and compared with ANFIS, Adaptive FLC, Reduced-order FL, FOPI, and FOFL. The PQ issue in the system is helped by the UPFC device. A shunt active power filter is used in series with an Artificial Neural Network (ANN) with an ALO-based controller to improve UPFC performance by allaying current and voltage power quality (PQ) concerns. It proved that our proposed system is best in smart grid applications using MATLAB/Simulink.

Keywords: UPFC**,** ALO,ANFIS, Adaptive FLC, Reduced-order FL, FOPI and FOFL Smart Grid, MATLAB/Simulink.

INTRODUCTION

There are no dispensing devices, nonlinear loads, or utilities employed as compensation in the electrical power system. This complicated structure guides the power system toward an unsteady energy source [1]. complicated energy systems known as "smart grids" (SGs) utilized two-way communication between distributed generation (DG), control systems, and loads to improve voltage stability, create the good utilization of RES, self-repair systems when a problem arises, and provide customers with the chance to control their electricity usage and save funds on maintenance cost [2]. Regardless of the complexity of most attacks, the Energy station represents a unique confrontational goal in the smart grid. [3]. Series and shunt compensators are combined in UPQC. Upgraded maximum frequencies, dynamic reactive and active energy control, voltage sag, voltage disbalance, voltage flicker, and voltage are all outcomes of its use [4]. Even from the end perspective, the user's PV technology has become the most enticing. Due to its dependability and simplicity, applications. However, scheme intricacies like load variations and parameter modifications may prevent PI/PID control from functioning normally even when it is perfectly aligned [6]. As an outcome of the power system's unsteady or disruption of synchronization, Due to a lack of dissipative torque, these vibrations become more intense. The major scheduling approach is defined as time-based operational, or demand based. In these systems, the power scheduling is operated based on the measurement of demanded power and the available generation [8-10]. Where advanced algorithms were deployed for proper decision-making, all the existing approaches were based on discrete parameter monitoring. Here, the characteristic of the demand variation is not been considered. Longer periodic observation of the demand may lead to a more accurate switching performance of the generation units.

The Foremost Contribution of the Proposed Methodology

- UPFC with ANT-LION optimization (ALO) algorithm is proposed and compared with ANFIS, Adaptive FLC, Reduced-order FL, FOPI, and FOFL to develop a weight-specified parameter tracking of power planning in multi-parametric monitoring, where the past method of priority scheduler is to be established.
- UPFC performance can be improved by easing concerns about current and voltage PQ by using an ANN with an ALO-based controller.
- To use and schedule the virtual generation plants in demand-supply, a hybrid system of virtual power units must be integrated and scheduled, from which a balance relation between generation and demand must be derived. Utilizing the MATLAB/Simulink environment, every parameter must be verified.

LITERATURE SURVEY

In this section, a few relevant works on intelligent controllers for smart grid performance are examined.
Rahbari, O, et.al., have offered a flexible control system that makes the smartest grids, electric cars with plugs, and renewable energy sources. This study suggests a workable solution to the issues associated with integrating renewable energies & into the electrical grid for electric vehicles, considering source generation unpredictability & uneven energy use, by using a new adaptive intelligent controller.It is suggested to use an innovative hybrid control

strategy based on the optimum power flow issue and just a neuro-fuzzy adaptive inference system with particle swarm optimization resulting in a rise in the voltage's total harmonic distortion rather regularly. Irfan, M. et.al., have proposed, Possibilities and difficulties in managing smart grids from a Pakistani perspective.This paper provides a thorough analysis of developments in smart grid control.The methodologies are highlighted by the smart grid.Pakistan must make use of its natural resources, including wind, hydropower, and solar energy. To reduce future energy shortages, urgent action is required. Bayindir, R. et.al., have suggested Applications for smart grid technology. This paper analyzed data transmission methods, smart grid applications, and technological energy efficiency in smart grids.Scientists and engineers investigating the smart grid are expected to find this study to be a key source of direction. Derakhshan, G. et.al., have discussed improving demand response programs in smart grids.The following four types of residential consumers were surveyed for this study, which was conducted on some residential houses in Tehran, Iran, during the summer:When payment costs for various periods are reduced, our optimization model employs the Shuffled Frog Leaping (SFL) algorithms & Teaching & Learning Based Optimization (TLBO)to plan smart grid utilization.

He, Y., et.al., have proposed, using an intelligent mechanism based on deep learning, the smart grid can identify fake information injection attacks in real-time. In this study, FDI assaults' behavioral characteristics are detected using deep learning methods. historical measurement data is employed, and the behavioral features are then used for real-time FDI attack identification. Keshtkar, A. et.al, have proposed wireless sensors, smart grids, and fuzzy logic for smart home load reduction. In order to reduce the load on HVAC systems in houses, this study offers a Fuzzy Logic Technique (FLA) that provides wireless sensors and smart grid incentives. A PCT that can handle TOU & RTP is being constructed in MATLAB/GUI to mimic a real thermostat. It functions as a "simulator engine" to assess FLA's effectiveness in various contexts. The main objective of energy systems and smart grids is the integration of household HVAC technologies in the context.

PROPOSED METHODOLOGY

The system's load demand increases as a result of the increased utility use brought on by urbanization and industrialization. Regarding protection and energy reliability and performance troubles, integrated approach sources are unable to satisfy the required energy needs in today's modern power grid.To resolve these issues, dispersed energy resources and RES have been utilized.The most cutting-edge technology currently in use, the RES system, can boost system steadiness and effectiveness.Among the most practical remedies for PQ problems like voltage sag, sale, and fluctuation is the FACT system.Therefore, UPFC is employed in the RES in this paper to address these power quality issues.A PV system that is linked to the smart grid makes up the suggested RES.The RES is linked to a smart grid, which results in issues with power quality due to nonlinear loads, critical loads, and unexpected loads.This results in a problem with reactive power mismatch and more voltage instability.The UPFC may be the best tool for dealing with power quality issues and enhancing voltage regulation in RES linked to the smart grid. The modeling approach is depicted in Figure. 1 and includes batteries and photovoltaics linked to a smart grid. To meet the needs of the customer, RES is used. The battery energy storage system is utilized to distribute essential electricity and store excess power generated by solar panels. Power quality issues in RES systems connected to the smart grid are the primary concern in maintaining stability and dependability conditions. To handle PQ difficulties including sag, swell, and fluctuation, a UPFC is constructed using a smart grid-connected RES system.

Method for storing energy in batteries

Systems that store energy in batteries are utilized to meet load demands when the RES power supply is insufficient.

$$b^*_P = p^*_{PV}(t) + p^*_{WT}(t) - \frac{P^*_I(t)}{\varepsilon^*_i} \quad (1)$$

$P^*_I(t)$ = Demand for system load,
b^*_P = Battery power.

An important battery feature known as the State of Charge (SOC) is linked to RES's inability to produce enough energy and excessive power production as shown in equation 1.

PV cell analogous circuit:
The quantity of solar panels interconnected in a Photovoltaic system in series and parallel determines the voltage, current, open-circuit voltage & short-circuit current.

DC-DC converter analogous circuit:
Figure 3 shows a circuit equivalent to a DC-DC boost converter. Switch 1 is initially closed, while Switch 2 is initially in the open position. Inductor L's (I_L) current is now starting to rise from zero. The inductor current flows to the load at this point while the capacitor stores the charges, & switch-two is closed and switch one is opened. When the output voltage is stable, the ON-OFF states of switches 1 and 2 fairly represent the contingent excessive value of the output voltage.current.

Load(smart grid, AC load):
The three-phase electric power system is the industry standard for generating, distributing, and transmitting alternating current. It is a type of polyphase system, and in most cases, the most widely used way to transfer power in the world's electrical grids. It is also possible to use to power large motors and other heavy loads. Results and discussions

Case 1: Mitigation of Sag Signal
The voltage sag is to be corrected in order to ensure linear and consistent system operation. By providing the necessary voltage with the help of UPFC, to meet the needs of the load, the voltage is rectified. The voltage from the source, injection voltage, and load voltage are all shown in a sag analysis in Figure 4.
ANFIS is contrasted with the modified sag signal produced by the proposed method. Signals that are already in use include Adaptive FLC, Reduced order FL, FOPI, and FOFL. The suggested method corrects the sag signal in a time window of 0.15 to 0.3 seconds. Regarding sag correction, the suggested method performs better than convolutional alternatives.

Case 2: Mitigation of Swell Signal
The performance of the suggested method is estimated using the swell condition. By combining the flaw with the source, the swell condition is introduced into the system. Examining the swell state, varying the sources, and rating the performances. Additionally, the injected voltage for the swell signal is compensated using the ANTLINE built on the UPFC, and the compensated load voltage is ultimately reached at 440 V. The swell signal is decreased in the suggested method over a time interval of 0.15 to 0.3 sec. In comparison to other techniques, the effectiveness of voltage swell alleviation as can be observed from this graph, the proposed method is better than ANFIS, Adaptive FLC, Reduced order FL, FOPI, and FOFL. In comparison to reduced order FL, Adaptive FLC, and ANFIS, the swell signal is greatly diminished.

CONCLUSIONS

This paper described the improvement of PQ carried out by the proper design of control techniques in a grid-connected RES with the load. The RES's irregularity causes PQ problems, which the ANT-LION optimization algorithm methodology attempts to address. The simulation results are used to analyze the various PQ troubles, such as voltage sag and harmonics, to show how superior the proposed work is. The proposed work's mitigation level is greater than that of the current algorithms. The percentage of THD, which is 2.07%, is also examined and contrasted with the THDs of traditional algorithms. In comparison to traditional algorithms, the suggested technique's UPFC with ANT-LION optimization algorithm is more effective.

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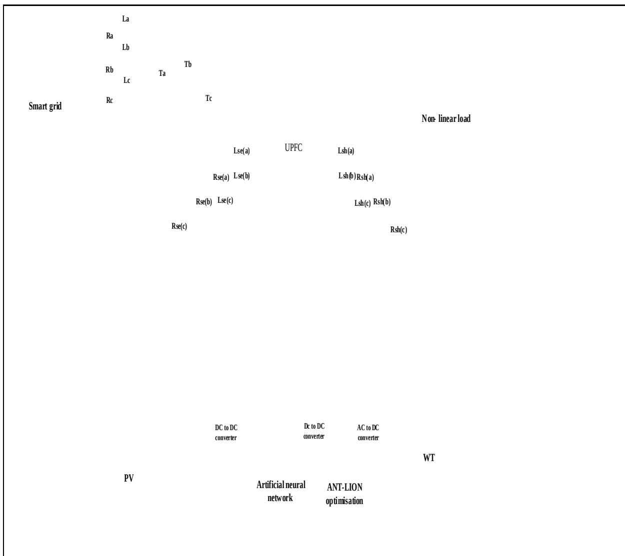

Figure 1: UPFC structure with smart grid connectivity and RES

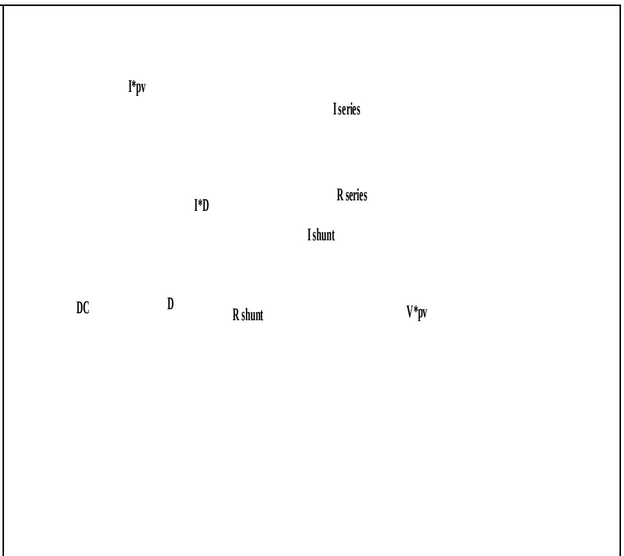

Figure 2. PV cell analogous circuit

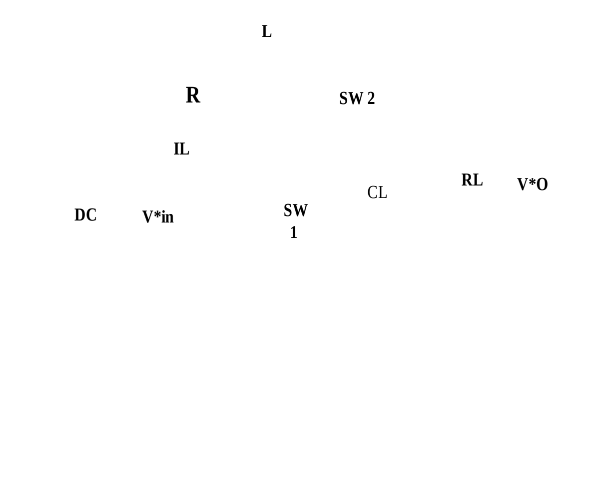

Figure 3: DC-DC converter analogous circuit

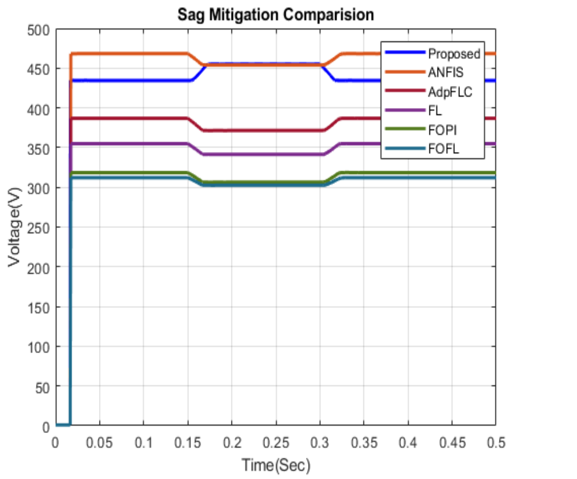

Figure 4: Comparison of sag mitigation

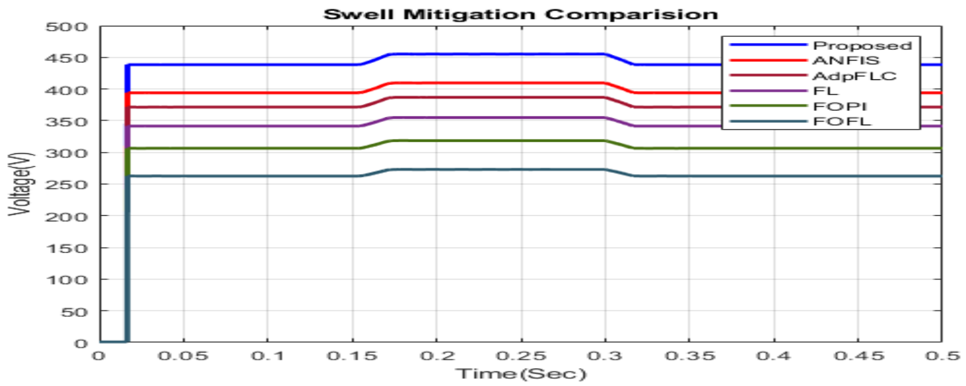

Figure 5: Comparison of Swell mitigation