International Journal of Emerging Trends in Science and Technology (IJETST) Volume 03 Issue 01, 2017
ISSN.: 2349-7866

UPQC Based Control Strategy for Weak / Islanded Grids

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Abstract: This paper presents nonlinear optimal stabilizing controller using a Unified Power Quality Conditioner (UPQC) is proposed for weak / islanded grids. The stabilizing controller benefits for the microgrid due to their relatively small energy levels stored and islanded medium size grid, which effect of stability as microgrids. To outline an ideal lattice stabilizer is utilized Hamilton–Jacobi–Isaacs ideal control technique. When presence of renewable energy for the power quality enhancement in the DS. The settling control is added to the UPQC arrangement, to stabilize a Grid Tie Inverter (GTI) or Synchronous Generator (SG) with medium effort of control. The proposed UPQC structure that only employs the series compensator, when GTI controlled related to renewable energy sources. Next, the approximate cost function is used neural networks with successive approximation method, in a two game player for the zero sum game with the players being UPQC control and microgrid influences. The simulation done by MATLAB / SIMULINK software is obtained.

Keywords: Discrete-time optimal control, Flexible Alternating Current Transmission System (FACTS) devices, Hamilton–Jacobi–Isaacs (HJI), Microgrid, Neural Networks (NNs), Power System Stability (PSS), Virtual Synchronous Generator (VSG).

I. INTRODUCTION

As of late, the utilization for Unified Power Quality Conditioner (UPQC) has proposed to systematic control quality in circulation frameworks, if not at all like in extensive frameworks variables, for example, load harmonics and imbalance because of renewable energy resources are more serious in littler lattices [1]–[4]. In additional, dynamic reliability and secure operation a testing operation, low energy level in small grids. FACTS devices, then again, have been used to enhance transient reliability in transmission system other than the control game theoretic approach [5]–[11]. Also, in microgrids and distribution system, UPQCs can be provided with reasonable balancing out systems to upgrade the strength of the distribution system in expansion to their energy quality abilities.

For a long time, the direct framework assumption has been connected to control networks, keeping in mind the end goal to relieve motions that happen after unsettling impacts and give strength [10], [11]. Be that as it may, these methodologies expect that the system factors stay in an operating point. The ideal control issue in power framework looks for not exclusively, to balance out the framework, additionally to line, the speed motions successfully with least force those outcomes in lower electrical control on the stuff while keeping up the execution.

The nonlinear optimal controller distributed system required to understand the Hamilton–Jacobi–Isaacs (HJI) condition [15]. The taken a toll work in HJI can be approximated by utilizing disconnected what's more, online guess techniques. Disconnected techniques [17]–[22] require already gathered informational collections for preparing as restricted to online strategies [24]–[26] that locate the ideal controller continuously form, and in this way, no informational indexes are required earlier to prepare. While online strategies unwind the need of substantial informer indexes, they locate the ideal arrangement with bigger faults and require the perseveringly energizing information [24], [26].

The discrete time nonlinear optimal control of power inclined to constrained way of distribution system. In this paper, ideal adjustment of the weak grids / islanded grids system include renewable energy sources and ordinary synchronous generators is examined. The objective of this paper is to balance out the framework, as well as likewise, to accomplish the strength with least control exertion (cost) keeping in mind the end goal to lessen electrical stress on the controller's energy electronic gadgets and increment their lifetime. The powerful matrix might be operational with traditional stabilizers. Here, the term weak grid is used suggest minimum size and islanded control systems for non high put away energy. When UPQC has customarily acquainted with enhance the nature of force at the appropriation level, the paper's objective is to demonstrate that by UPQC controlled arrangement voltage, settling ability included to the implement to enhance transient dependability least realized, particularly in little estimated networks. Be that as it may, finding the ideal settling control for the annoyed network, refers to comprehending the nonlinear optimal HJI condition.

In this paper expands [16] in the nonlinear optimal discrete-time control field and improves the theoretical outcomes in that control matrix strength thinks about. Initially, a real nonlinear optimal discrete time dynamical model network operational with UPQC is created. The successive approximation method is suitable for system wind energy turbine associated through a grid tie inverter and also networks with SGs. In this system explain the high cost depletion with the system controller. In this manner, the network's HJI detailing is introduced what's more, comprehended for a high work by using a simple calculation in a two-player zero-entirety model approach utilizing dynamic programming where the players are UPQC control unknown disturbances of the grid. Next, the nonlinear optimal controller is acquired utilizing work and is connected with UPQC. Then reason of the model is that it doesn't consider a limitless transport, as limitless transport does not exist for power grid medium put away energy levels, for example, islanded grids or weak grids. Or maybe, created demonstrate considers variety of the transport voltages as unsettling influences in the HJI format. At that point, the discrete-time HJI method created control is attempted utilizing two-player strategy emphasis in the controller to get the objective work. The successive approximation approach utilizes for the Taylor series system of work what's more; estimate neural networks system properties [27] to inexact the approximation cost, system unsettling influences. At the time, from the good work, the UPQC nonlinear control arrangement controller was found that limits the work and mitigates the motions ideally. The restoration comes about on practical networks demonstrate the adequacy of the nonlinear optimal UPQC controller over the customary methodologies. Whatever is left of this paper is whatever remains of this paper are sorted out as takes after. To start with, the discrete-time system, involves UPQC is determined of Segment I. Then, the foundation data of the nonlinear optimal control system are displayed in Segment II. Thusly, the network's HJI plan is led, a successive approximation approach is used to settle the HJI condition for work utilizing NN in Area IV. The controller balancing out is tried utilizing reenactments in Area V, when the conclusion is given in Segment VI.

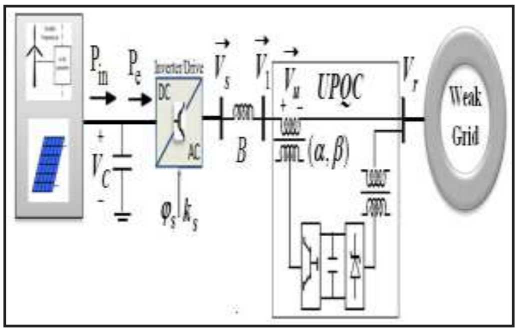


Fig. 1: RG Associated with Weak Network through DC Connection and Inverter

II. Demonstrating the System UPQC with Grid

In this power controller with UPQC method is created in this area through delivering power adjust conditions. The different types in the UPQC transport voltage are demonstrated as an obscure aggravation influencing the flow of system.

A. UPQC Show

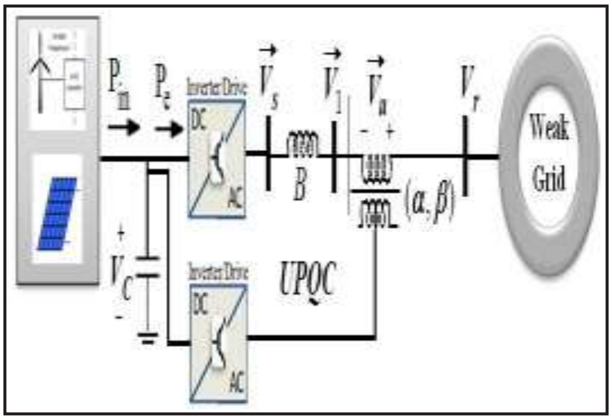


Fig. 2: The Power System with Connected to the UPQC

The UPQC related with the system shows up in Fig. 2. The UPQC involves two areas: 1) a shunt mode and 2) a series mode. The guideline commitment of the shunt mode is to control the voltage degree at the sending-end, transporting producing or engrossing force, compensate for load imbalance and sounds, and give asked for unaffected power at the UPQC. DC interface for the game plan converter. The plan branch compensates for the line current sounds. The shunt mode and power quality execution of the UPQC are not pointed in this paper; rather, the course of action branch is used to enhance grid's dauntlessness as an additional limit added to the routine undertakings of the UPQC. UPQC game plan mode can be shown as a controlled voltage source, spoke to by the shunt mode voltage. Fig. 3 shows up the UPQC voltage phasor diagram.

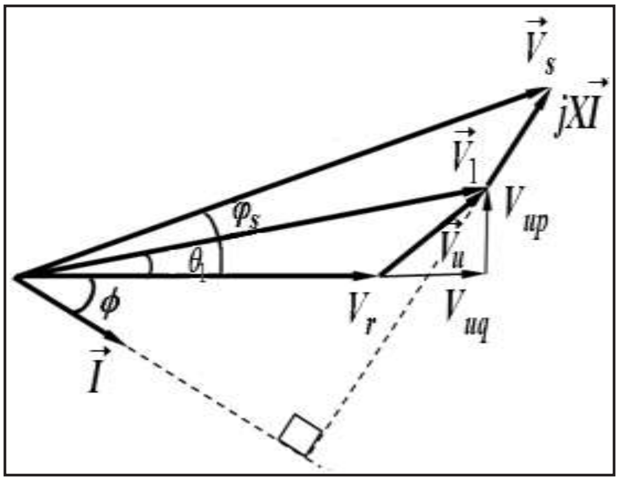


Fig. 3: UPQC Voltage for Vector Diagram

Despite the fact that method is significantly produced for the networks, involves wind control, it is useful to talk about sun based power for the specific condition of the proposed optimal control. The control instance of PV cells encounters extraordinary alterations of homeless people than wind turbine. Sun oriented voltage is a component the DC-connect voltage for the situation that no dc-dc converters are used line the sunlight based cells to the GTI. Then the input control Pe is being partitioned consistent and different parts like the UPQC controller voltage where the different power can be incorporated unsettling influence. An option arrangement is to utilize a DC-DC converter with enough quick reaction consistent rates.

B. HJI Condition for the Successive Approximation Method

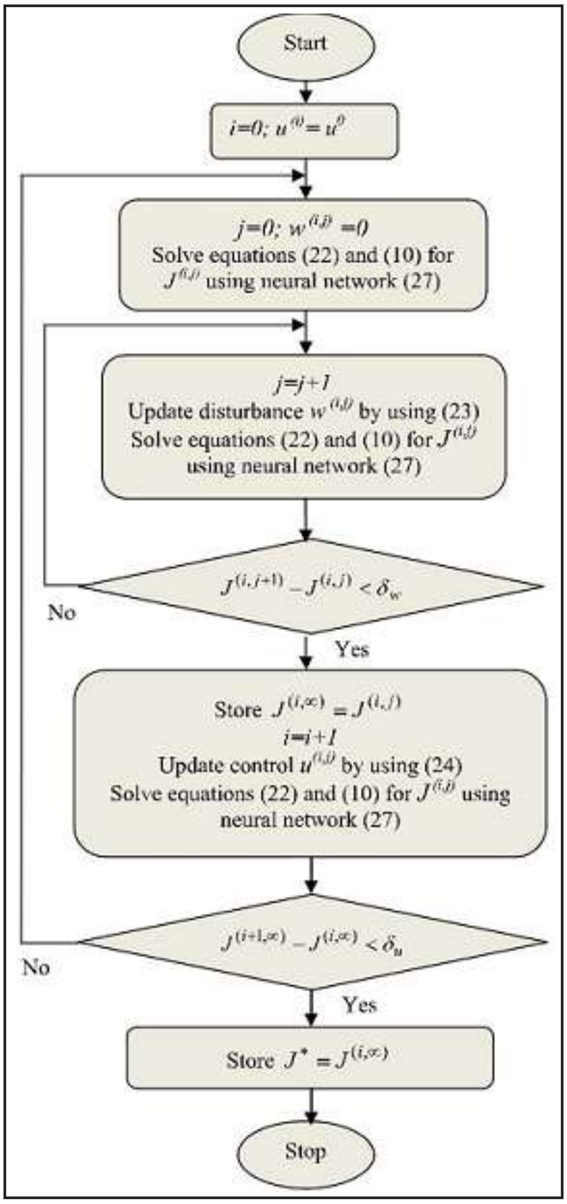


Fig. 4: Find Out the Cost Function of Successive Approximation Procedure

The proposed system used in this algorithm, performs as scheme through the two loops.

Once NN weight should calculate for this cost function and optimal controller obtained each iteration of the algorithm.

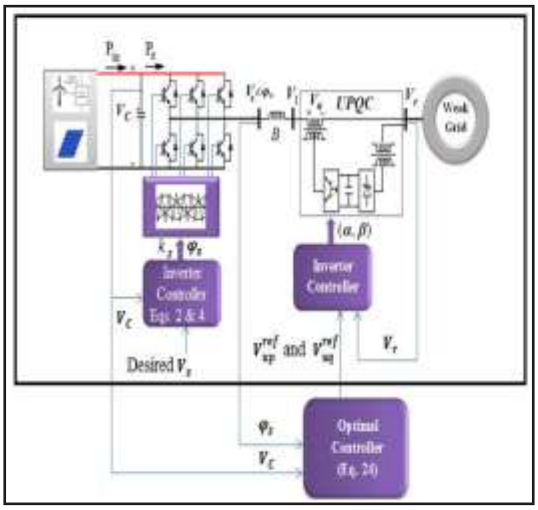


Fig. 5: Block Diagram of Proposed System

III. Simulation Results

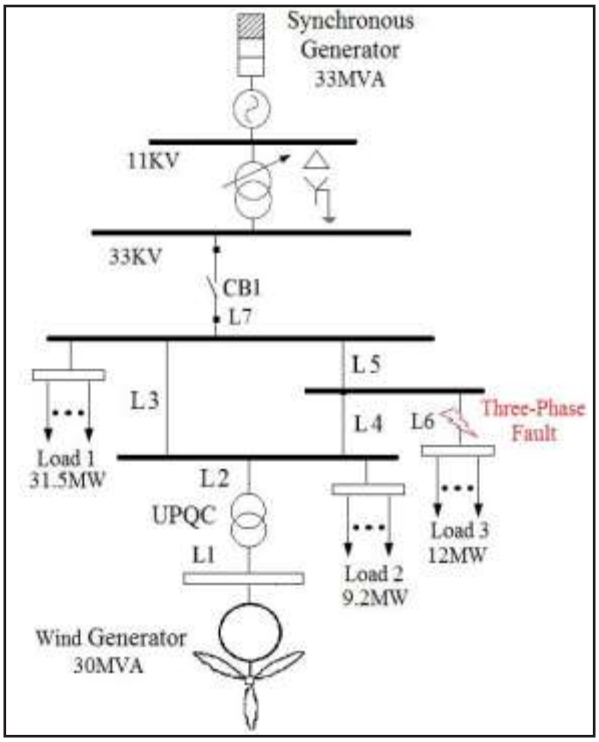
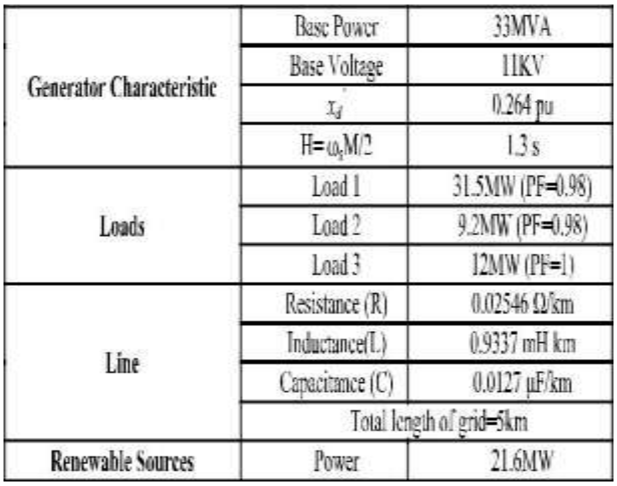


Fig. 6: Weak Grid Connected with Wind Form

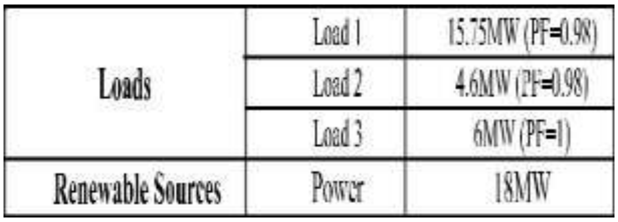
In this simulation section are carried out on islanded grids / weak grids. To obtain proposed UPQC structure optimal controller method in Fig. 4 and apply to the synchronous generator, GTI in the microgrids.

Table I: High Power Parameter



Generator Characteristic	Base Power	33MVA
	Base Voltage	11KV
	x_d	0.264 pu
	$H=\omega_0 M/2$	1.3 s
Loads	Load 1	31.5MW (PF=0.98)
	Load 2	9.2MW (PF=0.98)
	Load 3	12MW (PF=1)
Line	Resistance (R)	0.02546 Ω/km
	Inductance(L)	0.9337 mH km
	Capacitance (C)	0.0127 µF/km
	Total length of grid=5km	
Renewable Sources	Power	21.6MW

Table II: Low Power Parameter



Loads	Load 1	15.75MW (PF=0.98)
	Load 2	4.6MW (PF=0.98)
	Load 3	6MW (PF=1)
Renewable Sources	Power	18MW

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At the appointed time UPQC arrangement infused distribution system affairs in the voltage and power in the transmission lines utilizing the nonlinear optimal controller are in worthy ranges simulation results as appeared in Fig. 7 and 8. The correlation of nonlinear optimal controller doesn't fault conditions at low load levels. Fig. 7 Contextual analysis 1 - UPQC arrangement examination of non optimal nonlinear controller, high and low load levels. Fig. 8 Contextual analysis 1 - work correlation non optimal controller and the proposed optimal controller - low load levels. Most extreme UPQC power is 1.5MW that is 7% of the transmission line control.

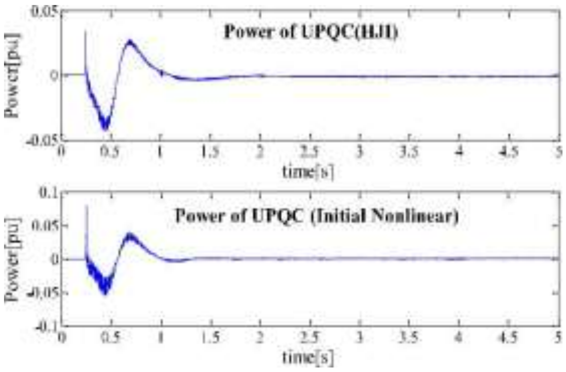

Fig. 7: The Proposed Optimal Controller is Comparison of UPQC Power

Take note that of the ideal way of the proposed controller effect bring down controller exertion occur the same damping controller execution contrasted and the underlying nonlinear settling controller [28], as appeared in Fig. 7. Fig. 7 speaks to work [29] correlation for the controllers where the optimal nonlinear controller for 20% of the lesser control. Generally speaking, Fig. 8 show graph demonstrates proposed controller ordinary PI controller and PSS and also nonlinear optimal controller [28].

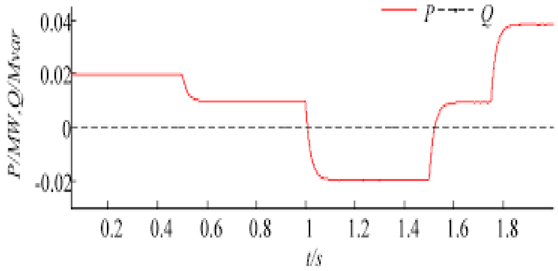

Fig. 8: The Cost Function of Non Optimal Proposed Controller at Low Load Levels

Next, the nonlinear optimal controller [28] is maintaining the high and low load level appeared in Table I and Table II obtains a similar error situation. Fig. 7 and 8 demonstrate the affable execution of the control checking power of the optimal control at various working focuses for examination.

Next, the show diminished UPQC structure displayed in examined when the nonlinear controller [23] is connected in the arrangement of Fig. 6. Fig. 7 and Fig. 8 demonstrate the damping execution of the ideal controller with the power electronic devices structure utilizing the parameters of Tables for I and II.

IV. Conclusion

The optimal stabilizing control is used discharge signal for wind energy resources and distribution system associated for islanded microgrids. The successive approximation approach, the matrix supplied with an UPQC is demonstrated as an optimal discrete time nonlinear controller dynamic system that suits SG and GTI in weak matrix and islanded grid, and along these lines unending transport doesn't estimated. In this way, a two game player diversion method is embrace outline a HJI condition through progressive estimate of work utilizing neural networks. The nonlinear controller is connected to the improve signals in the weak/islanded system. At the point when connected to game theoretic approach, a lessened UPQC structure is demonstrated compelling enhancing safety security system.

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