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Review on Improvement in Stability of Hybrid Series Active Power Filter by Using Sliding Mode Controller

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ABSTRACT: The poor power quality had affected the utilities and customers in many ways. The current harmonics and voltage harmonics are the major power quality issues and these can me minimize byusing HSAPF ie.HybridSeries Active Power Filter. In this paper, a new approach is introduce as a solution. The new controller will design using sliding mode controller-2 to enhance the performance of the HSAPF.to make them more robust and stable. Also different existing control strategies are given in this paper. Furthermore this paper highlights how effective approach it is to implement the new strategy to meet the desires.

KEYWORDS:HSAPF (Hybrid Series Active Power Filter,SMC(Sliding Mode Controller), power quality,APF(Active Power Filter),PPF(Passive Power Filter).

I.INTRODUCTION

From last few years, the vast use of non-linear loads, caused lots of power quality problems like harmonics in current, harmonics in voltage etc. on utility [1]. These non-linear loads gives rise to theharmonics in currents and injects it in power lines. This disturbed supply voltage and current gives malfunctionof protecting devices, burn out of transformers as well asheating of cables. For that it is essentialto compensate the harmonic currents which were produced by the nonlinear loads and hence we introduce various kind of compensation devices. Generally, passive power were installedfor the compensation. Thisfilter suppress harmonic from the current at the lines through a low impedance pathand give out the pure supply and hence an improved power quality [2]. But , passive filters suffers from disadvantages like mistuning, resonance, being dependenton the power supply conditions of the entire system as well ashuge values of passive component that results in heavyinstallations. For better power supply, newcontrol scheme active power filters are series connected or parallel connectedto the end of line nearer to the load sideresulting in improved and better power supply.These filters have wide rangesolution,because they can effectively eliminate current distortion and the reactive power produced by non-linear loads.But because of high cost and the losses during their operation they have drawbacks [3] [4]. So to diminish these disadvantages as well as to enhance the performance of compensators with having low cost of the APFs, a new HSAPF topology- III is presented by Peng et al. in 1988 [5], in which APF is series connected with the source and non-linear load also PPFis parallel connected at theload side, which can correct the power factor. It can isolate the harmonics from source and the load. The control technique is essential to improve the behavior of HSAPF. In last decade there are many more strategies are developed or implemented for improvement of power quality. In this paper some of them are introduced. In this paper the new control strategy is presented.The sliding mode control is known as aperfectcontrol scheme for handling non-linear loads from the sudden dynamics and obstructions due to its decreasing order phenomenon and less sensitivity, this is the basic concept about the sliding mode controller.

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II.LITERATURE SURVEY

Existing control schemes

1.Linear feedback-feed-forward controller- In this method harmonics are eliminated based on -based feedback controller used forShunt Hybrid Active Power Filter (SHAPF) to eliminate the harmonics an to perform a satisfactorily operation, due to the destructions such as phase delays because of controller technique and measurement circuits, tolerances of passive filter components also harmonics in supply voltage[6]. In this proposed controller, the traditional feedback controller is enhanced with the help of supply side individual current harmonics which then eliminated by the method of synchronous reference frame. To overcome the poor behavior, variousdisturbances, proportional–integral controllers are implemented to each *d* and *q* components of individual current harmonics. This strategy is implemented form the improvement of the performance of the SHAF. But this controller is not sufficient to give steady state and transient state responses. But it becomes difficult to track continuous feedback hence the system is not stable.

2.The proportional resonant compensator- The Proportional Resonant Regulator has been introducedaccording to LC resonant circuit [7].This compensator can give steady-state error forreference because it have a high gain for its resonance frequency. Moreover a same regulator hadintroduceddependent on mathematical transformation along effective synchronous frame PI, which can track a reference for the same frequency as the rotating frame having zero steady-state error. The Proportional Resonant regulator selected in has the transfer function given in and given by following equation. It gives an improved phase margin also transient performance in closed loop operation.

$$C(s) = k_p + \frac{k_r s}{s^2 + \omega_0^2}$$

where proportional gain(k_p), resonant term gain(k_r) and resonance frequency(ω_0). Butthis application have limitations of selecting proper constants.

2. Artificial Intelligence Techniques-In APF, we cannot find the algorithm which van give a correct reference signal of harmonic for the control action, this is the severe problem. Generally in the practical area where the system have time varying harmonics and frequency. Hence due to these conditions the new approach was established and that is ANN [8]. This technique is implemented for the APF. The ANNs-based techniques are very effective in active power filters. Furthermore, more number ofimplementations proved that ANNs are help to install various parts of an APF. An Adaline is use to detect the discrete signal variables of the power supply voltage. MLPs detects the harmonic also filters them, while feed-forward and recurrent neural networks are used to search harmonics into distorted wave. In this way, an enhancement of the processing also a resolution of the harmonic identification algorithm is found. This process can make good outcomes than traditionalprocesses for signals. Isolation of high-order harmonics is derived by combining the series active filter and parallel passive filter. A genetic algorithm given for finding the parameters of a RST regulator for a PLL loop control for detect the positive sequence of network voltage. This helps to harmonic detection of the APF. Hence, Adaline identify the frequency of power system. This method gives a high degree of strongest and calculated accuracy over large Ares of frequency changes.

3. Linear Quadratic Regulator (LQR)- Linear Quadratic Regulator (LQR) by Integral deed (LQRI) for a three-phase three-wire shunt active filter (SAF)[9]. The integral deed is supplementaryforwithdraw the steady-state errors for reference tracking or disturbance refusal, significant that the typical LQR offerssolitary proportional gains. The controller is intended to attain dc bus voltage guideline and harmonics and reactive power recompense. The converter model is set inthe $d-q$ revolvingposition frame. The last is increasedbythe vital of the *q* section of the SAF currents and dc bus voltage to attainvitaldeed. The controller's presentationrest onon the increment matrix, which is chosen to ensure satisfactory response. The converter is controlled as a whole, i.e., a multi-input–multi-output system and a secure pulsewidth modulation at 10 kHz is used to producethe gating signals of the power procedures. The scheme is tested for harmonics, reactive power, and load disturbrecompense for balanced/unbalanced loads. The new results found with a digital signal processor-based application of the controller on the *DS1104* of dSPACEdisplaynoblepresentation in terms of dc bus voltage directive (minorovershoot and actual fast time response) and a little total harmonic falsehood of ac line currents. But this control scheme requires to choose the proper switching

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surfaces. Then, the discontinuous control needs to be select in such a way that any of the state outside of the discontinuous surface are enforced to reach the surface at finite time.

4. Linear Quadratic Gaussian (LQG)- Linear Quadratic Gaussian (LQG) is a Servo controller used for control of Shunt Active Power Filter (SAPF) working under different load conditions[10]. This LQG controller is combination of a LQ regulator and a Kalman filter (KF) that reduces the error between the output currents as well as their changes. In LQG Servo controller there is a feedback compensator, that is a advantage to the SAPF system, which increases tracking error elimination, gain stability, lowers the amplitude distortion and sensitivity to external peripherals. A Kalman filter generates new reference current which overcomes the drawbacks of a proportional integral (PI) controlleralso does not use the voltage sensors resulting in its cost effectiveness. Hence, this reference system have self-capability of dc-link voltage regulation by effectivelyguessing the peak value of source reference current with varying load circumstances. The control process is entrenched in SAPF by a MATLAB/Simulink software environment. The efficiency of the projectedprocess is assessed through evaluation with aprevailingprocess and then authenticated with trialrevisionstrailed using a dSPACE1104 figuring platform. From the found experimental and simulation fallouts it is observed that the planned control methodshowsgreaterperformance in terms of sturdinessupgrading and current harmonics vindication under steady-state and active load conditions, thus creating it extraoperative for appliedclaims. But this control scheme requires to choose the proper switching surfaces. Then, the discontinuous control needs to be select in such a way that any of the state outside of the discontinuous surface are enforced to reach the surface at finite time.

5.Fuzzy immune PID controller -As per the PID variables have high impact on the presentation of a series hybrid active power filter(SHAPF).A new fuzzy-immune-PID controller was intended built on the principle of fuzzy immune feedback and PID control, which was used to control a series hybrid active power filter[11]. The controller can effectively trace and compensate harmonic. A three-phase series hybrid active power filter be there simulated in Matlab/Simulink7.0 by using SimPowerSystems Blockset. By examining the simulation results, we can see that the series hybrid active power filter based on new fuzzy immune-PID Control has a great skill of precise and a good real time presentation. A relative study on the between various control methods' recompense presentations demonstrations that the series hybrid active power filter based on novel approaches can remove harmonic current successfully.

III.SYSTEM MODEL

❖ Basic principle of sliding mode controller

A adaptable system is composed of numerousconstant subsystems by a swapping logic. The subsequentcontroller action is aintermittent function of the system state. A specific operation is accomplished when the swapping occurs at an identical high frequency, ideally infinite, making the system state to a surface, named sliding surface. Thisprocess is known as ideal sliding mode (SM) and has severalsmart properties. It is robust to parameter uncertainties and external disturbances, the closed-loop system is an order-reduced one, and its dynamics depends on the designer-chosen sliding surface.

❖ Why Should We Use Sliding Mode Controllers?

- It is very robust and stable.
- It can be simply modified.
- It can handle MIMO systems.
- Ample simpler than its other algorithms.
- It is fast acting device and cheaper than the other control strategies.

❖ System model design & assumptions

The sliding mode control is recognized as apropermechanism for monitoring non-linear schemesthroughinexact dynamics anddisordersowing to its order decrease property andsmall sensitivity to disorders and plant

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limitationdeviations, which decreases the freight of the necessityof carefuldemonstrating. Also, this sliding mode controllikewisereduces the complicacy of feedback control strategyvia means of decoupling the scheme into separate subsystems of minormeasurement. Since these given belongings, the application of sliding mode control can be form in the areas of power electronic switching devices. The norm of sliding mode control is distinct as to impose the sliding mode gesturein a predefined switching surfacesof the system state space byintermittent control. The switching surfaces should be nominated in such a way that sliding gesture would keeppreferred dynamics of gesturerendering to definitepresentationstandard. Accordingly, sliding mode ariseslaterally the surface, and the system monitors the wanted system dynamics. The main trouble of hardware employment of traditional sliding mode control technique is babbling. Babbling is nobody but an unwantedoccurrence of fluctuationthroughlimited frequency and amplitude. The babbling is unsafeas the system delays control correctness, great wear of stirringmachine-driven parts, and high heating losses arises in electrical power circuits. Babblingarises because of unknowing dynamics. These u unknowing dynamics are formedas of servomechanisms, sensors and data processors bylesser time constants. In sliding mode control the switching frequency should be significantlygreatsufficient to create the controller more vigorous, stable and no babblingsincebabblingdecreases if switching frequency of the system rises. The presentation of sliding mode controller in power converter systems for illustration in HSAPF, a normaltechnique to decreasebabbling is growing switching frequency. Though, it is not promising in case of power converters since of assuredboundaries in switching frequency for harms in power converters, for which it effects in babbling. Thus, this babblingdelinquent cannot responsibility sliding mode applicationas it is mostlyaffected by switching boundaries. In [12], it is presented that the babbling exponentially be likely to zero if the absolute degree of the system with actuators or sensors is two. The absolute degree of HSAPF system is two. Since this absolute degree of HSAPF system and likewise for these problems in conventional sliding mode controller, this paper projected a novel controller i.e. sliding mode controller-II[13]. This projected controller intimidatedbabbling and improve the presentation of HSAPF. This controller is totally new for this topology of HSAPF system.The basic concept of HSAPF and the sliding mode controller is shown in following diagram;

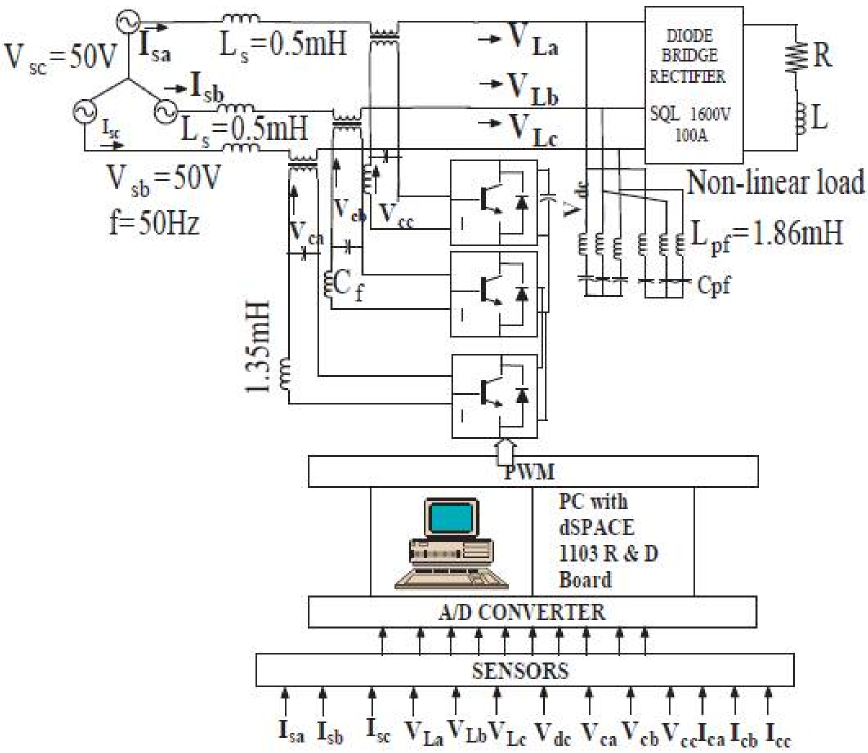

Fig.1 Basic concept of Hybrid series active power filter.

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The paper [14] emphases on carrier based PWM (CBPWM) aimed at HSAPF topology. Then in specific cases the CBPWM based HSAPF may not be totallyassessable in maximum of the practicalcircumstances. In case of CBPWM, power system distresses have not been taken into thought and likewise the existence of a time delay at the positionchasing point offersincrease to a slow reaction of the complete system. Thus, chasing error is not eliminatedefficiently and steadiness of the system is marginallyupgraded. To overwhelm this, a new SMC controller is projected for voltage source converter (VSC). The impressionahead this controller is to attain gain steadiness, perfect chasing and falsehood free current and load voltage.

In opinion of above statedproblems, givesadditionalimportance on the expansion of vigorous controller with a quicker reference chasingmethod in HSAPF, which approvals all distresses such as load voltage falsification, parametric distinction of load, source current alteration and supply voltage disturb so that compensation ability of the HSAPF system can be improved.

IV.CONCLUSION

In this paper, the new proposed controller is introduced for HSAPF. The control scheme issliding mode controller that enhance the performance of HSAPF. This control scheme is useful for switching pattern generation also to set reference. It gives steady state alsotransient response, by applying this control scheme the performance of the HSAPF can be improved. It cangive uselimination of voltage and current harmonics, reference set valued voltage settings, and compensation of reactive power under various load conditions. In this paper different control strategies are presented like linear feedback-feed-forward controller,Artificial Intelligence Techniques,Linear Quadratic Regulator (LQR),Linear Quadratic Gaussian (LQG). The proposed filter can eliminate source current distortions and hence it can also adjust itself for the different non-linear load currents, and power factor correctionat the supply side nearer to unity.

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