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Reweighted L_0 norm variable step size continuous mixed p-norm control scheme for mitigating power quality problems of grid coupled solar PV system

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Abstract— **In this paper, authors analyzed the performance of two stage-three phase grid coupled solar photovoltaic generating system (SPVGS) by using novel reweighted L_0 norm variable step size continuous mixed p-norm (RL_0-VSSCMPN) of voltage source inverter (VSI) control scheme. The efficacy of the system is determined by considering unbalanced grid voltage, dc offset, voltage sag and swell, unbalanced load and variation in solar insolation. RL_0-VSSCMPN is used for inverter control and it extracts fundamental component of load current for generating reference grid current with faster convergence rate and lesser steady state oscillations. With the proposed control, harmonics in grid current follows the IEEE-519 norm and the performance is also satisfactory under varying environmental/load conditions. The power generated from SPVGS is transferred optimally using dc-dc boost converter utilizing incremental conductance (INC) maximum power point technique. The proposed system is simulated using MATLAB/Simulink 2018a and test results are verified experimentally using dSPACE1202 in the laboratory to ensure the validity of novel proposed robust RL_0-VSSCMPN.**

***Index Terms*-- INC maximum power point tracker, power quality, reweighted L_0 VSSCMPN algorithm, solar PV generating system, total harmonic distortion, voltage source inverter.**

I. Introduction

Solar photovoltaic generating system is one of the most important green source of energy. Stand-alone as well as grid coupled system are keenly accommodating this transformation of energy which is a big boon and positive step for SPVGS. But the solar energy is available only when the sun shines and the maximum power point unceasingly fluctuates due to weather condition. So, to extract maximum power from solar photovoltaic system, maximum power point tracking (MPPT) is used [1], [2]. Many MPPT control algorithms are reported in literature like perturb and observation, incremental conductance, adaptive neuro fuzzy system, genetic algorithm etc. [3]–[6].

Solid state device-based loads have made our life easier but they also draw harmonics from the utility grid and raises power quality issues like poor power factor, unbalancing etc. Grid coupled SPVGS also necessitate these power electronics components. Voltage source inverters are used to mitigate the power quality issues. So, an efficient VSI control technique becomes imperative as it reduces the reactive power demand from utility grid and reduces harmonics

Some of the VSI control schemes reported in literature are synchronous rotating frame theory (SRFT), unit template, *dq* control theory, instantaneous reference frame, second order generalized integrator (SOGI), adaptive based control and are presented in both power factor correction (PFC) as well as zero voltage regulation mode [7]–[12]. Phase lock loop (PLL) is used to convert three phase quantities into two phase in SRFT control algorithm. But it requires proper tuning before implementation. There are many modification of PLL reported in literature [13]–[16] which shows zero steady state oscillations but are incapable of rejecting dc offset component. A. Mortezaei [17] presented comparative analysis of *pq*, *dq* and conservative power theory (CPT) for shunt active compensators. The *dq* provides pure sinusoidal grid current under distorted current condition. Also, the *dq* has faster response than other presented techniques but it fails to reject the ripples in current for unbalanced load. The SOGI control can estimate the fundamental component of load but is unable to discard the direct current offset in load current. Furthermore, the systems performance under distorted grid voltage has not been considered. Various artificial intelligence-based PV inverter control algorithm are also reported. S. Nanda et al. in [18] gives new control adapting filter based on modified Gauss–Newton (MGNA) for calculating fundamental and harmonic phasors of non - linear power system waveforms as well as frequency change. N. Gupta et al. [19] implemented fuzzy controller for PV inverter control of grid connected SPV system. The membership function of the fuzzy are asymmetrically distributed which helps in early settling of dc-link voltage as compared to other conventional methods. The total harmonics distortion (THD) is within IEEE norms under steady state and dynamic situations. Authors in [20] have developed an intelligent controller named as Takagi-Sugeno-Kang type Probabilistic FNN having an Asymmetric Membership Function (TSKPFNN-AMF) for three phase grid integrated PV system. Authors have discussed the network structure, online learning algorithms, and convergence of the developed controller. Further the performance of TSKPFNN-AMF has been compared with PI, PID, FNN and WFNN techniques. But these techniques require proper tuning before its implementation.

Many adaptive control schemes such as least mean square (LMS), least mean fourth (LMF), zero attracting LMS,