Gajjala Prashanth Reddy* et al.
(IJITR) INTERNATIONAL JOURNAL OF INNOVATIVE TECHNOLOGY AND RESEARCH
Volume No.4, Issue No.5, August – September 2016, 4149-4153.

Using Minimal Load Power Observer To Optimize System Cost And Reliability

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Abstract: **The previous term is made to result in the system errors converge to zero, whereas the second term is used to pay for those system uncertainties. Furthermore, the perfect load current observer can be used to optimize sys-tem cost and reliability. Particularly, the closed-loop stability of the observer-based optimal current control law is in past statistics proven by showing the whole states from the augmented observer-based control system errors tremendously converge to zero. This paper proposes an easy optimal current control way of three-phase uninterruptible-power-sup-ply systems. The suggested current controller consists of a feedback control term along with a paying control term. Unlike previous algorithms, the suggested method can produce a tradeoff between control input magnitude and tracking error simply by selecting proper performance indexes. The potency of the suggested controller is validated through simulations on MATLAB/Simulink and experiments on the prototype 600-Veterans administration test bed having a TMS320LF28335 DSP. Finally, the comparative recent results for the suggested plan and also the conventional feedback linearization control plan are given to show the suggested formula achieves a great performance for example fast transient response, small steady-condition error, and occasional total harmonic distortion under load step change, unbalanced load, and nonlinear load using the parameter variations.**

Keywords: **Optimal Load Current Observer; Optimal Voltage Control; Three-Phase Inverter; Total Harmonic Distortion (THD); Uninterruptible Power Supply (UPS);**

I. INTRODUCTION

Lately, the significance of the UPS systems continues to be intensified increasingly more because of the increase of sensitive and demanding applications for example communication systems, medical equipment, semiconductor manufacturing systems, and knowledge processing systems. These applications require clean power and reliability whatever the electrical power failures and distorted utility supply current. The traditional PI control recommended to apply however, the THD worth of the output current isn't low within nonlinear-load condition [1]. One predictive control way of UPS applications is described. Using a load current observer instead of current sensors, the authors claimed a lower system cost. However, the simulation and experimental results don't reveal a fantastic performance when it comes to THD and steady-condition error. Multivariable FLC this control technique, the nonlinearity from the product is thought to achieve low THD under nonlinear load. However, it's not easy to handle because of the computation complexities. Consequently, these straight line controllers are pretty straight forward; however the performance isn't acceptable under nonlinear load. In comparison, the nonlinear controllers come with an outstanding performance; however the implementation is difficult because of the relatively complicated controllers. Hence, a straight line optimal controller has not just a simple structure in comparison to other controllers but additionally an outstanding control performance much like other nonlinear controllers. Therefore, this paper proposes an observer-based optimal current control plan for 3-phase UPS systems. This suggested current controller encapsulates two primary parts: a feedback control term along with a paying control term. The previous term is made to result in the system errors converge to zero, and also the latter term is used to estimate the machine uncertainties. The Lyapunov theorem can be used to evaluate the soundness from the system. Specifically, this paper proves the closed loop stability of the observer-based optimal current control law by showing the system errors tremendously converge to zero. Furthermore, the suggested control law could be systematically designed considering a tradeoff between control input magnitudes and tracking error unlike previous algorithms. Within this paper, a standard FLC technique is selected to show the comparative results because it features a good performance within nonlinear-load condition, and it is circuit type of a 3-phase inverter is comparable to our bodies' model. Finally, the outcomes show the suggested plan includes a good current regulation capacity for example fast transient behavior, small steady-condition error, and occasional THD under various load conditions for example load step change, unbalanced load, and nonlinear load. The inductive element here is required to take away the switching frequency harmonics in the current waveform that originate from the PWM operation from the inverter. The inductance value could be reduced when the switching frequency is elevated. Our prime-performance controllers generally employed multi loop condition feedback control strategies to offer the regulation specifications. The independent regulating each phase provides easy balancing of three-phase voltages making heavily unbalanced loading possible [2]. Also, it avoids problems for example transformer saturation. Lately, the proportional plus resonant (PR) controller has acquired recognition due to its simple structure and performance. The PR controller method essentially supplies a high gain limited to the preferred frequencies and for that reason extremely effective in correcting the steady-condition error and acquiring a great tracking from the reference in the reference frequency.

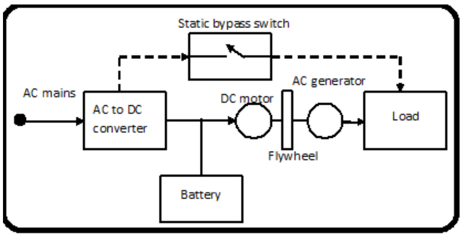


Fig.1.Block diagram of rotary UPS

II. LINEAR AND NONLINEAR HARMONICS

The normal definition for any harmonic is "a sinusoidal element of a periodic wave or quantity getting a frequency that's an important multiple from the fundamental frequency."Some references make reference to "clean" or "pure" power as individuals with no harmonics. The regularity from the harmonics differs, with respect to the fundamental frequency. To become in a position to evaluate complex signals which have a variety of frequencies present, numerous mathematical methods were developed. One of the most popular is known as the Fourier Transform. There's additionally a special group of interharmonics that are frequency values under the essential frequency value, known as sub-harmonics. The primary causes of harmonic current are in present the phase position controlled rectifiers and inverters." They are frequently known as static power converters. Hands-held harmonic meters could be helpful tools to make place checks for known harmonic problems. However, harmonic values will frequently change throughout the day, as different loads are switched off and on inside the facility or perhaps in other facilities on a single electric utility distribution system. Uninterruptible power supplies are emergency power sources that have endemic applications in critical equipments, for example computers, automated process controllers, as well as in hospital instruments. UPS includes following units. Conversion and inversion circuitry: All of the UPS systems incorporate a rectifier or charger circuit to supply Electricity to charge battery as well as an inverter circuit that converts the Electricity power kept in battery to AC capacity to operate the loads [3]. The precise type, nature, size and excellence of this circuitry rely on the kind of UPS. Battery: Apart from the conversion and inversion circuit, a different one is battery, which supports the energy which is used by UPS to operate the burden. How big battery dictates how big the UPS which is also proportional to the quantity of soaped up that kept in UPS and run duration of UPS for any given load. All batteries are rated when it comes to their nominal current (in Volts), as well as their capacity (in Amp-hrs or "Ah"). Status indicators: The majority of the UPS systems include number of indicators to point the present status from the UPS. Visual indicators (usually LEDs) are utilized to indicate general status in addition to problem conditions. Audible indicators, sometimes known as alarms, are utilized to indicate some problem conditions like power failure. A few of the typical status indicators are online, on battery, overload, Low battery, Load status, Battery status. The main topologies are: on-line system, off-line system and line interactive. On-Line System: The inverter in on-line system forces the burden continuously. It's also known as floating system and it is mostly employed for low, medium, and power applications. The charger includes a transformer for current scaling and offers isolation Safety purposes. The inverter is coupled to some transfer switch 2 (that is normally closed within this type), whose output is associated with the burden. Once the utility power is on and it is put on a rectifier/charger which gives electricity current towards the inverter, and keeps a float condition around the battery. This really is suggested for the diagram with thicker lines. Off-line systems: For conditions in which the utility power is neat and not susceptible to abnormal current excursions or transients, an off-line system could be employed to power a lot [4]. AC mains power is used straight to the burden with the transfer switch1 (NC). The rectifier/charger needs only charging current and operating at no-load. Once the utility power fails, a sensing circuit actuates the transfer switch and also the load is operated by the inverter. When there's an abrupt alternation in load, the inverter output current is decreased and monitoring circuits signifies the inverter malfunctioning. Once the power returns, the transfer switch1 is again actuated and cargo is directly linked to supply. Rotary UPS: In situation of highly critical applications the rotary UPS systems are extremely attractive no matter its space needs foot it of static [5]. A rotary UPS system utilizes a motor-generator set, using its rotating inertia, to ride through brief power interruptions.

III. SIMULINK MODELS AND RESULTS

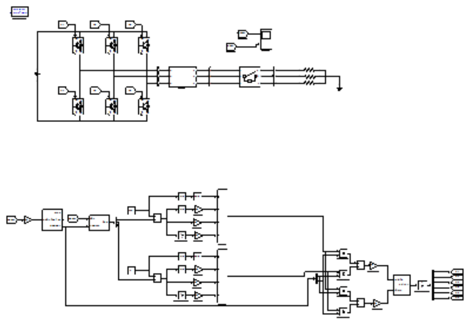
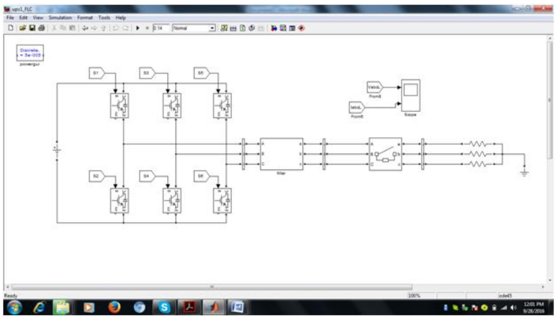


Fig. Comlete Simulink Model With Conventional Fuzzy Logic With Step Load Change



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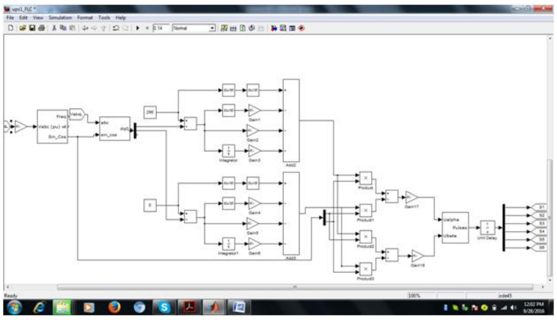

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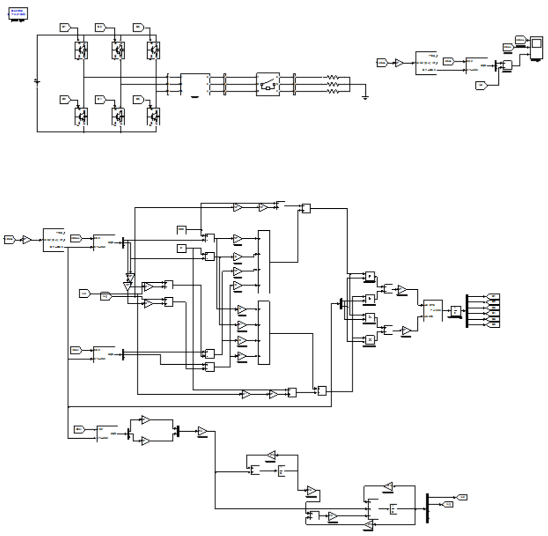
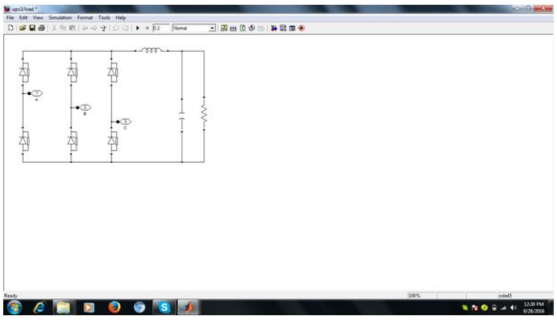


Fig: Simulink Model Of Proposed Obsever Based Otimal Voltage Method



IV. SIMULINK MODEL FOR NONLINEAR LOAD

CASE1: proposed observer based optimal voltage control scheme under load step change with −30% parameter variations in Lf and Cf (i.e., balanced resistive load: 0%–100%)

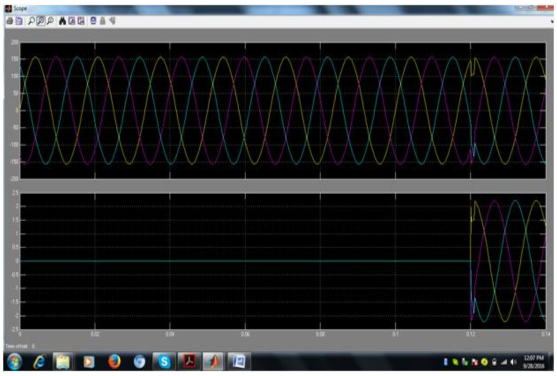


FIG.conventional FLC scheme under load step change with −30% parameter variations in Lf and Cf (i.e., balanced resistive load: 0%–100%)—First: Load output voltages (VL), Second: Load output currents (IL)

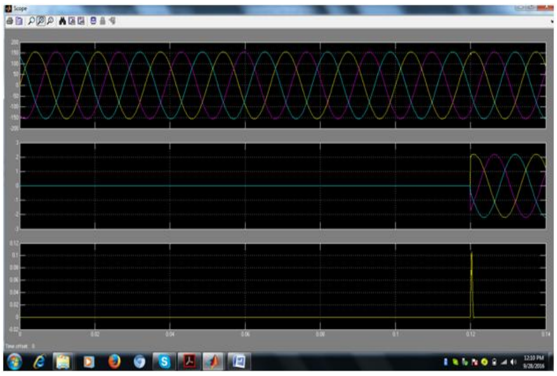


FIG: optimal voltage control scheme under load step change with −30% parameter variations in Lf and Cf (i.e., balanced resistive load: 0%–100%)—First: Load output voltages (VL), Second: Load output currents (IL), Third: Phase A load current error (ieLA = iLA −ˆiLA).

CASE2:

UNBALANCED LOAD

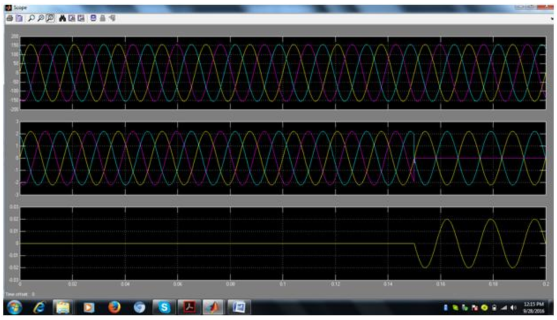


FIG.Simulation results of the proposed observerbased optimal voltage control scheme under unbalanced load with −30% parameter variations in Lf and Cf (i.e., phase B opened)—First: Load output voltages (VL), Second: Load output currents (IL), Third: Phase A load current error (ieLA = iLA −ˆiLA).

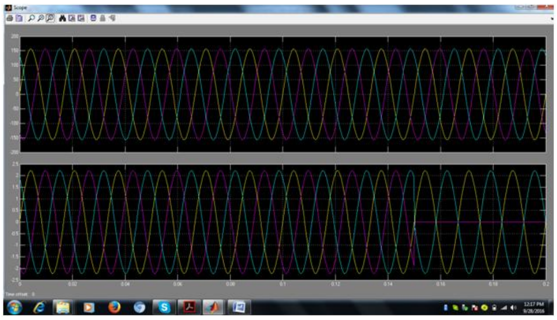


FIG.Simulation results of the CONVENTIONAL FLC control scheme under unbalanced load with −30% parameter variations in Lf and Cf (i.e., phase B opened)—First: Load output voltages (VL), Second: Load output currents (IL), Third: Phase A load current error (ieLA = iLA −ˆiLA).

CASE3:

NONLINEAR LOAD

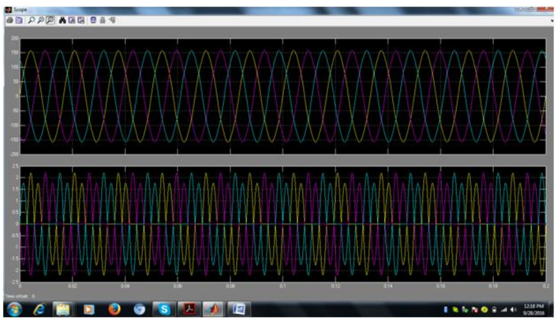


FIG.Simulation l results of the conventional FLC scheme under nonlinear load with −30% parameter variations in Lf and Cf (i.e., three-phase diode rectifier)—First: Load output voltages (VL), Second: Load output currents (IL).

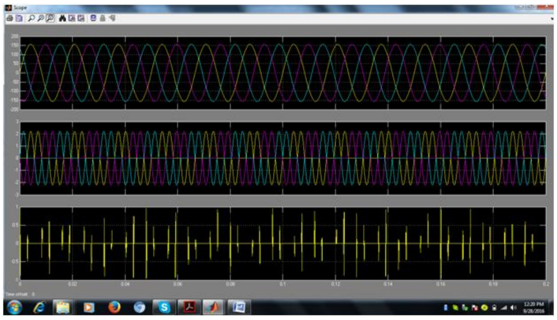


FIG5.Simulation results of the proposed optimal voltage scheme under nonlinear load with −30% parameter variations in Lf and Cf (i.e., three-phase diode rectifier)—First: Load output voltages (VL), Second: Load output currents (IL).

V. CONCLUSION

This paper has suggested an easy observer-based optimal current control approach to the 3-phase UPS systems The suggested controller consists of a feedback control term to stabilize the mistake dynamics from the system along with a paying control term to estimate the machine uncertainties. Furthermore, the perfect load current observer was utilized to optimize system cost and reliability. This paper demonstrated the closed-loop stability of the observer-based optimal current controller using the Lyapunov theory. In addition, the suggested current control law could be methodically designed considering a tradeoff between control input magnitude and tracking error unlike previous algorithms. The highest performance from the suggested control system was shown through simulations and experiments. Under three load conditions (load step change, unbalanced load, and nonlinear load), the suggested control plan revealed a much better current tracking performance for example lower THD, smaller sized steady-condition error, and faster transient response compared to conventional FLC plan even when there are parameter variations.

VI. REFERENCES

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