International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249 – 8958, Volume-9 Issue-1, October 2019

A Fuzzy Logic Control Method for MPPT to Improve Solar System Efficiency

Anurag A. Sutar, M.C. Butale

Abstract*: *Solar energy is act clean as well as renewable source of energy. Hence the use of PV systems has used in many applications. Big-spread use has resulted in decreased solar panel production expenses. But the low effectiveness of a solar panel owing to variables such as solar insulation, clouds and shading impact continues one of the greatest issues. Due to variable concentrations of isolation, the panel output remains variable during cloudy weather. To increase the solar panel's efficiency, the maximum algorithm for power point tracking needed as it was discovered only a small percentage of the energy incident is transformed into electricity. DC-DC Converter (Boost Converter) design helps to increase the panel output, thereby improving effectiveness and output voltage using reasonable control technique. This article discusses the development of the fluctuating MPPT logic control to track the maximum output point and also to compensate for fluctuating power during cloudy weather. The suggested primary circuit block diagram. The simulation study is carried out and the proposed circuit is implemented by hardware. MATLAB Simulink is used for simulating the circuit.

Keywords* : *DC –DC Converter, MATLAB SIMULINK, MPPT, Solar Panel.

I. INTRODUCTION

The world's population growth implies a growing need for sustainable energy resources. The consumption of energy, always increasing, decreases reserves of fossil fuel (oil, coal.). The consequences of these natural reserves ' massive exploitation could be serious: the world's industry would suffer from a fossil fuel scarcity and their combustion may cause air pollution and global warming gases. The use of renewables is a solution to these problems, thanks primarily to their insignificant impact on the environment and the fact that they are plentiful and available. The generation of photovoltaic renewable energy encourages growing interest politically and commercially. Photovoltaic (PV) systems have exceeded the optimistic estimations due to their many benefits, such as the delivery of green renewable energy through the use of solar power, autonomous operation without the generation of noise. They are also suitable for applications for domestic energy and small energy generation with ease of use.

Power variations caused by atmospheric conditions, however, apply in the PV systems.

Revised Manuscript Received on October 15, 2019

Anurag A. Sutar, Lecturer, Department of Electrical Engineering, Sanjay Bhokare Group of Institute Miraj, Maharashtra, India

M.C. Butale, Assistance Professor, Dept. of Electrical Engineering Padmabhooshan Vasantraodada Patil Institute of Technology, Budhagaon, Maharashtra, India.

The operation of PV energy conversion systems is therefore important to the maximum power point "Fuzzy Logical Control Method for MPPT for improving solar system efficiency" (MPP) so that the electricity generated for a given set of atmosphere conditions can be improved.

In the literature several methods for monitoring the MPP of PV systems have been proposed. Hill climbing belongs to these methods. Algorithms for disturbance and observation (P and O) were frequently used because of their direct and cheap operation. These methods suffer from the operating point oscillations around the MPP, leading especially in the large-scale photovoltaic systems in particular to significant energy losses. The method for increment inductivity is an alternative approach, which overcomes this effect. However, under changing atmospheric conditions, all these methods do not respond correctly.

II. DIFFERENT MPPT CONTROL METHODS

A. **Fractional Isc**

B. Fractional Voc

C. Incremental Conduction

D. Perturb and Observe

E. Fuzzy Logic

F. Neural Network

III. LITERATURE REVIEW

Photovoltaic (PV) solar renewables are the most environmentally friendly energy. It's built on clean and effective modern technology, which provides a glimpse of a sustainable hope for the future technology without pollution. Renewable energy, including solar photovoltaic (PV) systems, are of significant importance in these days because demand for electricity is rapidly growing worldwide. Solar energy is directly transformed by solar PV module into electricity. The specific characteristics of each type of PV module correspond to their circumstance, as ttemperature and irradiation,, and this makes tracking a maximum power (MPP) complicated. Many maximum power point tracking algorithms (MPPT) have now been presented to overcome this problem. Using Fuzzy Logic (FL) to track the MPP of PV modules since it has the advantages of robustness, is relatively easy to design with little accuracy. In this article, PV module, DC-DC converter mathematical models are used for studying the MPPT FL based algorithms

Maximum power point tracing(MPPT) is proposed in this paper. Photovoltaic system using Fuzzy Logic Algorithm in variable temperature and sunlight conditions. The cost of

PV power is more expensive than other non-renewable electricity sources. Therefore, the PV system must be operated in a high efficiency manner by tracking its max power point under any environmental conditions. Boost converter increases solar panel output tension. The output tension of the converter depends on the MOSFET service cycle present on the boost converter. Fuzzy logic controller senses the solar panel's output power to change its service cycle. The control system is proposed to adjust the DC-DC Converter Switch duty cycle to track a solar cell range's maximum power. The use for the development and design of PV array systems equipped with the MPPT controller is MATLAB Simulink.

IV. PROBLEM STATEMENT

Improving solar system performance using the Fuzzy Logic Control Technique to MPPT Tracking algorithm.

V. OBJECTIVES

The main purpose is to improve solar panel efficiency by using the MPPT tracking system.

VI. METHODOLOGY

Regardless of the ultimate location of the solar power, however, MPPT's main issue is that the effectiveness of transferring energy from the solar cell depends on both the quantity of sunlight falling on the solar panels and the electrical features of the charge. The load characteristic, which changes the highest power transfer efficiency as the sunlight amount varies and the system's efficiency is optimized when the load characteristic changes to ensure the maximum efficiency of the transmission of energy. This load feature is called maximum load point (MPP), and MPPT is the way to find this point and retain the load feature. The electric circuits can be designed so that the photovoltaic cells are loaded arbits and then the voltage, current or frequency converted into other devices or systems and MPPT solves the problem of selecting the best load available to cells to obtain the most usable output.

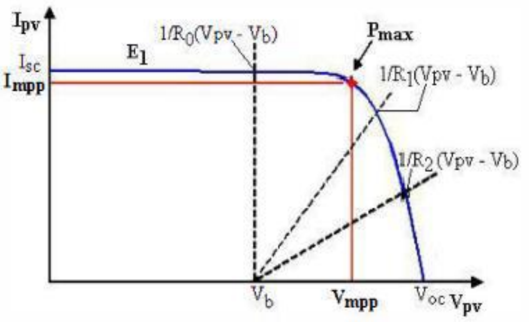

Fig 1 V-I Characteristics of solar panel

The panel's operating point will rarely be at maximum energy when a load is directly attached to the solar pv. The panel's impedance stems from the solar panel's working point. Thus, the working point can be shifted to maximum energy point by changing the impedance observed by the panel. Because panels are DC appliances, it is necessary to use DC-DC converters to convert the impedance from one circuit to another circuit. Varying the DC-DC converter's duty ratio outcomes in a panel-viewed impedance shift. The point of operation will be maximum energy transfer point at a specific impedance (should be duty ratio). With variability in atm circumstances such as radiance and temp, the panel's I-V curve can differsignificantly. Fixing the duty ratio with such dynamically shifting working circumstances is therefore not possible. MPPT implementations use algorithms to sample panel voltages and amperes commonly and then adjust proper the duty ratio as per our in this circuit required. To execute the algorithms, microcontrollers are used. Modern implementations often use bigger pcs to analyze and forecast loads. Solar energy is seen for the future as a clean and renewable energy source. In many applications, therefore, The use of PV systems has increased. The use of PV systems increased. Extensive use of solar panels has resulted in reduced costs for solar panels. Low solar panel efficiency due to such things as solar isolation, clouds and shading effect is still one of the most significant questions. In the cloudy weather the output of the panel continues to vary due to varying insulation levels. To increase the efficiency of the solar panel, maximum power-point tracking algorithms are required as only 30 to forty percent of the incidents are translated into electrical energy design enables to increase the panel output, thereby Improve efficiency and output voltage by means of appropriate control. The aim of this paper is to create a fluctuating MPPT logical control system that monitors the maximum power point and also offsets fluctuating energy during cloudy conditions. The main circuit diagram proposed. The simulation study is carried out and the proposed circuit is implemented hardware. MATLAB Simulink is used for simulation of the circuit.

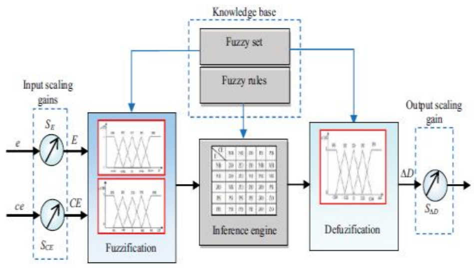

Fig.2 Fuzzy controller's structure.

A.Fuzzification

The fuzzification allows the transition from real variables to fuzzy variables. It is possible to measure the real vlt (V) and present (I) of the PV generator continually and to calculate the energy (P= V *I). The control is decided on the grounds of the fulfillment of two criteria pertaining to the suggested controller's two input factors, namely error E (representing the slopeof the P-I feature) and in this cicuit shift of this error (CE), at an instant sampling by value k.

$$E(k) = \frac{P(k) - P(k-1)}{I(k) - I(k-1)}$$

$$CE(k) = E(k) - E(k-1)$$

$$E(k) = \frac{\Delta P}{\Delta V} = \frac{P(k) - P(k-1)}{V(k) - V(k-1)}$$

$$CE(k) = E(k) - E(k-1)\ V_D$$

$$I_D = [\exp \frac{VD}{n\,VT}]$$

Retrieval Number: A9401109119/2019©BEIESP
DOI: 10.35940/ijeat.A9401.109119

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Where P(k) and I(k) are respectively the power and current of the PV generator. The E(k) Input therefore specifies whether an operating point on instant k is on the left or right of the P-I feature of the MPP, while the CE(k) input indicates the direction of this point to be displaced. As the output of the proposed controller, the change in the Duty Rate of the DC DC converter is used. This control is carried out by altering that duty ratio to path E(k) to return the operating point to an optimal point in which the pitch is nil. The input variables of the Fuzzy Controller (E, CE) are extracted from the real signals (e, Ce) by multiplying the respective escalations (SE, SCE) and are then transformed by using the fundamental Fuzzy subset into linguistic factors such as PB(Positive Large), PS (Positive Light), Z0(NE), NS (Negative Light). Five basic subset subassembly grades for factors of input and output. The interfering engine uses the laws for the furtive input. Five basic furry subset membership grades of input and output factors to determine fluid outputs. The interference engine uses the legislation for fluid input in order to determine the fluid outputs. Therefore, the crimped input levels must be fluctuated before the rules can be evaluated[16] in order to obtain the appropriate language values and the degree to which every portion of the precedent was satisfied with every rule. Tables.2 show a table of rules for the controller where Fuzzy Error Sets (E), Error Change (CE) and Duty Ratio Change (D) to converter are all matrix entered. Table.2 shows.

B. Defuzzification

The inferential methods have been shown to feature the resulting membership variable; they function as a consequence of fuzzy information. Because the DC-DC converter requires an exact D control signal to be entered in this process, a conversion of this fuzzy data to deterministic data is to be envisaged. Usually, the Areas Center (COA) and the MCM are two defuzzify algorithms that can be used. The most frequently used defuzzing technique is to determine the center of gravity (COA). The final mixed fuzzy set will be described by combining the entire fuzzy set of the rule output signal D in its entry to plan a transformation of this fuzzification information into deterministic information. Two algorithms: Area center (COA) and Max Criterion method (MCM) can be normally used to deflation. The most commonly used defuzzy method is to determine the final combined fuzzy set center of gravity (COA). The final fuzzy set is determined by the connection of all fuzzy rule output set

C. Inference engine

The interference engine applies the law on fuzzy inputs (one produced by the fuzzification method) to determine fuzzy outputs. to get the relevant language values (which must be determined in order to determine the active or fired rule) and to which the preceding parts have been satisfied for each rule, it is thus important to fluctuate the crisp input values before the rules are measured. The table below shows a floppy controller in which every matrix input is a floppy set of bugs (E), changing the tariff ratio (D) to the converter.

Table I Used in the Logic Controller Rule Base

E/C E	PB	PM	PS	ZE	NS	NM	NB
PB	ZE	ZE	ZE	NB	NB	NB	NB
PM	ZE	ZE	ZE	NM	NM	NM	NM
PS	ZE	ZE	ZE	NS	NS	NM	NM
ZE	NS	NS	ZE	ZE	ZE	PS	PS
NS	PM	PM	PS	NS	ZE	PS	ZE
NM	PM	PM	PM	PB	ZE	ZE	NS
NB	PB	PM	PM	PB	ZE	ZE	ZE

Table.I can display the 25 fugitive-control rules in 3-D, as shown in the figure. These rules are used to control the converter DC-DC buck, like the PV generator MPP. As illustrated in table 2, the primary concept of the guidelines was to raise or decrease the duty ratio to the MPP by the operational point based on the position of the MPP. The duty ratio is increased or mainly reduced if the operating point is far away from MPP. Exemplified in Fig.3(b): PB is IFE AND CE is NB Then alternate Ds are PB. This implies that the dust ratio is increased significantly if the point is remote from MPP to the left side and the slope change in P-I characteristic is large in the opposite direction.

The fuzzy control uses one of the following techniques: Max-Min, Max-Prod, Somme-Prod. In our situation we used the Mamdani inference technique, the Max-Min fugitive combination.

A converter is that raises voltage. DC to DC power converter from input (provision) into output (load) (when downstream current is set). A boost converter is used. It is a class of SMPS (Switched Mode Power Supply) which has at least two semiconductors (one diode and one transistor) and one energy storage element (one condenser, inductive, two combined). Filters made by condensers (in some cases in association with inducers) usually are added to the output (load-side filter) and the input of such a conversion converter (supply-side filter). The key factor driving The boost converter is the inductor's resistance trend current changes through the creation and destruction of a magnetic field. The output voltage of a boost converter is always higher than that of the input voltage.

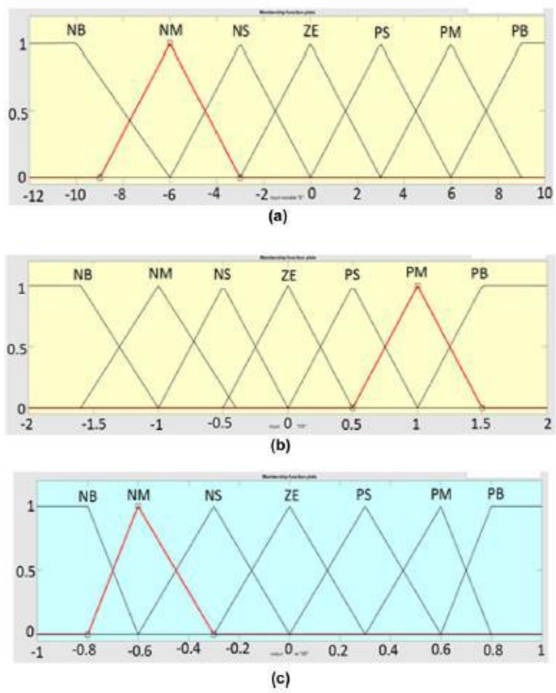

Fig.3 (a) FLC input (Error, E), (b) FLC input (Error change, CE), (c)FLC output (Duty, D).

a. If the switch is closed, the current flows in the direction of the inducer and the inductive energy is stored by generating a magnetic field. On the left of the inductor there is a positive polarity.
b. If the switch is opened, a higher impedance will reduce the current. The previously created magnetic field is destroyed in order to maintain the load current. So the polarity is reversed (the left side of the inductor is now negative). Thus, there are two sources charge the condenser through series diode D that causes a higher voltage.
If the switch is cycled sufficiently fast, the inductor will not fully discharge between charging stage, and when the switch is open, Load always looks a higher voltage than the input source itself. This combined voltage is charged in parallel to the load. The capacitor can therefore supply voltage and load energy when the switch is then locked and The right side from the left side is shortened. The blocking diode prevents the condenser from unloading through the intercom during this time. The switch needs to be opened again, of course, quickly enough to prevent too much discharge of the condenser.
Boost convertors have two basic requirements: The SW switch is closed in state, resulting in an increase in inductor currents; the switch is open in off state, and the only way of accessing the inductor current is via the flyback diode D, condenser C and load R. The switch is not available. This means that The accumulated on-state energy is transferred to the condenser.
The current input is the same as the current induction. Therefore, the buck converter is not discontinuous and input filter requirements are relaxed compared to the buck converter

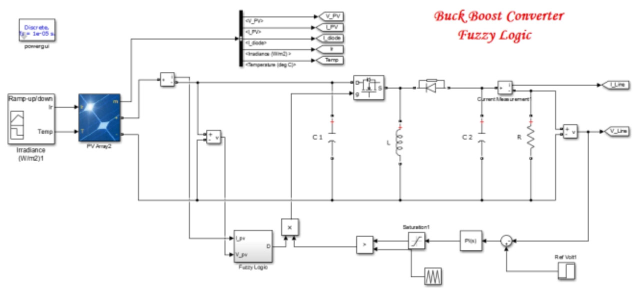

Fig.4 MATLAB SIMULINK Model FLC

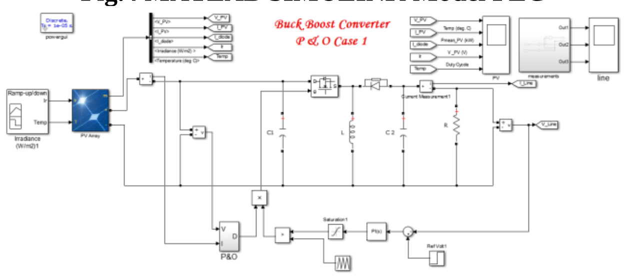

Fig.5 MATLAB SIMULINK model P & O

VII. HARDWARE IMPLEMENTATION

Solar panel cleaning system

In hardware of solar panel system there are two parts, one is solar panel cleaning and second is solar panel tracking. Solar system is cleaned by using cleaner of cloth with help of dc motor. With help of arduino program solar panel is cleaned by regular time intervals when signal is given by manually, when required. When signal is given to arduino, cleaning assembly stars to working and solar panel is cleaned and hence the system output is increased. Bidirectional dc motor cleans solar panel by to and fro of cleaner.

Fig. 6 Hardware Setup

VIII. RESULTS

To check the photovoltaic simulation system's MPP tracker, In various atmospheric circumstances the proposed MPPT technique is compared with P&O MPPT to demonstrate how the proposed MPPT technique can track peak energy under distinct circumstances effectively and precisely. MATLAB / STMULINK is used to simulate. The simulation model used is shown. The output of the MPPT control block is the gating signal that the MOSFET drives. The buck boost converter is designed for the highest energy levels. Under distinct atmospheric Circumstances, the MPP tracker must monitor the peak energy.

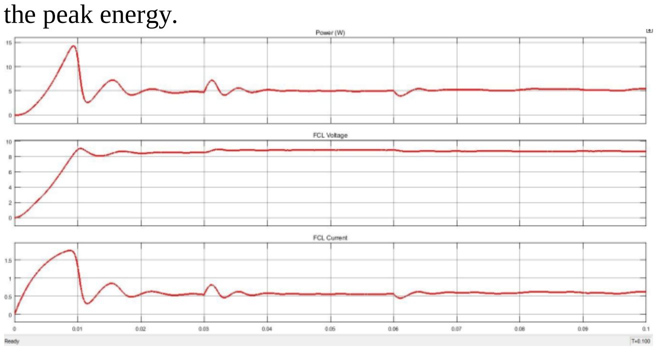

Fig. 7 Performance with FLC

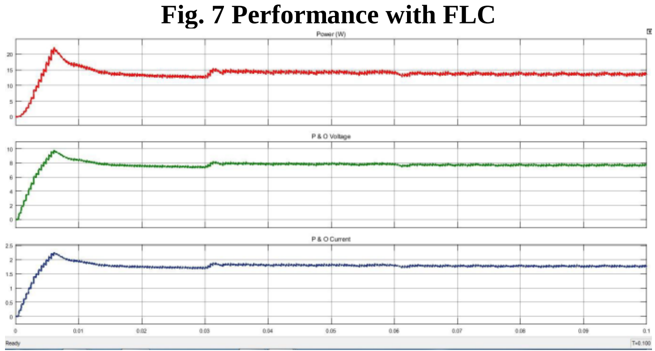

Fig. 9 Performance without FLC

Table II Result without tracking

HARDWARE RESULTS

RESULT WITHOUT TRACKING AT ANGLE=16.86+15=31.86°			
Sr No.	Time (Hrs.)	Voltage (volts)	Current (amp)
1	7 to 9	10 to 11	1 or above
2	9 to 12	11	1.5 to 1.9
3	12 to 14	12	2.5 to 3
4	14 to 16	12	2 to 2.5
5	16 to 18	11	1.5 to 2

Table III Result with tracking

RESULT WITH TRACKING					
Sr. No.	Time (Hrs.)	Voltage (volts)	Current (amp)	LDR 1(Ohm)	LDR 2(ohm)
1	7 to 9	10 to 11	1 or more	70 - 80	412-500
2	9 to 12	11	2 to 2.5	100-120	300-400
3	12 to 14	12	3 to 3.3	180-200	220-300
4	14 to 16	12	2.5 to 3	200-315	150-300
5	16 to 18	12	2 to 2.5	315-400	100-150

IX. CONCLUSIONS

This paper provides a photovoltaic model using Matlab / STMULTNK and design of the suitable DC-DC Buck-Boost Converter with maximum capacity. A new process is shown and compared to the traditional P&O MPPT method for MPPT-based fuzzy logic controller.. Both sun radiation and photovoltaic temperature are tested under perturbation. The simulation results show that under different environmental conditions effectively tracks the maximum power point in the proposed method. The oscillation around MPP is reduced and the response is faster than traditional methods. The comparison of tracking efficiency in both methods shows an increased efficiency of the proposed method MPPT over conventional method of P&O. Simultaneously system efficiency is increased by cleaning the solar PV cells to the great extend. Hence the overall efficiency is increased when the system having large capacity.

REFERENCES

1. V. A. K. Prabhala and Poria Fajri, “A DC-DC Converter with High Voltage Gain and Two Input Boost Stages,”IEEE Transactions on Power Electronics., vol. 31, no.6, June 2016.
2. Sri Revathi B and Mahalingam Prabhakar, “Transformerless high-gain DC–DC converter formicrogrids,”IET Power Electron., 2016, Vol. 9, Iss. 6, pp. 1170–1179 and The Institution of Engineering and Technology 2016.
3. Ali Ajami, HosseinArdi, and Amir Farakhor, “A Novel High Step-up DC/DC Converter Based on Integrating Coupled Inductor and Switched-Capacitor techniques for Renewable Energy Applications,”IEEE Transactions on Power Electronics., vol. 30, no.8, Aug.2015.
4. Manxin Chen, Kerui Li, Jiefeng Hu, and Adrian Ioinovici, “Generation of a Family of Very High DC Gain Power Electronics Circuits Based on Switched-Capacitor-Inductor Cells Starting from a Simple Graph,” IEEE Transaction on Circuit and Systems., Vol.63, no.12, Dec.2016.
5. W. Qian, D. Cao, J. G. C. Rivera, M. Gebben, D. Wey, and F. Z. Peng, “A Switched-Capacitor DC–DC Converter With High Voltage Gain and Reduced Component Rating and Count,” IEEE Trans. Ind. Electron no. 4, pp. 1397-1406, Jul. 2012.
6. Lung-Sheng Yang, Tsorng-Juu Liang and Jiann-Fuh Chen, “Transformerless DC–DC Converters With High Step-Up Voltage Gain,”IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 56, NO. 8, AUGUST 2009.
7. S. Saravanan and N. Ramesh Babu, “Analysis and implementation of high step-up DC-DC converter for PV based grid application,”12.094 0306-2619/ 2016 Elsevier Ltd.
8. C. Yuen-Haw, K.Song-Ying, “A Gain/Efficiency-Improved Serial Parallel Switched-Capacitor Step-Up DC-DC Converter,” IEEE Trans. Circuits and Systems-I: regular papers, vo1.60, no. 10, pp. 2799-2809, 2011.
9. Y. P. Hsieh, J. F. Chen, T. J. Liang, and L. S. Yang, “Novel high step-up DC-DC converter for distributed generation system,” IEEE Trans. Ind. Electron., vol. 60, no. 4, pp. 1473–1482, Apr. 2013.
10. S. Chen, T. Liang, L. Yang, and J. Chen, “A cascaded high step-up dc–dc converter with single switch for microsource applications,” IEEE Trans. Power Electron., vol. 26, no. 4, pp. 1146–1153, Apr. 2011. “A Fuzzy Logic Control Method for MPPT to Improve Solar System Efficiency”
11. H. Xuefeng and Ch. Gong, “A high voltage gain DC-DC converter integrating coupled-inductor and diode-capacitor techniques,” IEEE Trans. Power Electron., vo1.29, no.2, pp.789-800, Feb. 2014.
12. Y. Zhao, W. Li and Y. Deng X.He, “High step-up boost converter with passive lossless clamp circuit for non-isolated high step-up applications,”IET Power Electron., 2011, Vol. 4, Iss. 8, pp. 851–859.
13. S. Dwari and L. Parsa, “An Efficient High-Step-Up Interleaved DC–DC Converter with a Common Active Clamp,” IEEE Trans. Power Electronics. vol. 26, no. 1, pp. 66-78, Jan. 2011.
14. Fernando LessaTofoli, Denis de Castro Pereira and Wesley Josias de Paula, “Survey on non-isolated high-voltage step-up dc–dc topologies based on the boost converter,”IET Power Electron., 2015, Vol. 8, Iss.10, pp. 2044–2057 and the Institution of Engineering and Technology 2015.
15. Ki-Bum Park,Gun-Woo Moon and Myung-JoongYoun, “Non-isolated High Step-up Boost Converter Integrated with Sepic Converter,” IEEE Trans. power electronics, vol. 25, no. 9, September 2010.
16. Y. Ding, L. He and Z. Liu, “Bi-directional bridge modular switched-capacitor-based DC-DC converter with phase-shift control,” IEEE Energy Conv. Cong. and Expo., Milwaukee, WI, 2016, pp. 1-6.

AUTHORS PROFILE

Lecturer,Department of Electrical Engineering, Sanjay Bhokare Group of Institute Miraj, Maharashtra, India
anuragsutar77@gmail.com

Assistance Professor, Dept. of Electrical Engineering Padmabhooshan Vasantraodada Patil Institute of Technology, Budhagaon, Maharashtra, India.
mcbutale.ele@pvpitsangli.edu.in