GWO Based Controller for Converter in Grid Tied PV Systems

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Abstract-*As time goes on, developments in technology occur dramatically. The Grey Wolf Optimized Control Methodology for Converter in Grid-Tied PV System is demonstrated in the present investigation. A new algorithm for an optimization problem develops every day. The present study implements an optimization-based Tuned PI controller, commonly referred to as the Grey Wolf Optimized (GWO) Algorithm, to improve power quality in a distribution system by means of converter control in a grid-tied photovoltaic system. The MATLAB/SIMULINK environment is used to model the complete system. Finally, this work highlights how a Grid Converter's GWO-tuned PI controller can improve power quality by minimizing THD.*

Keywords: Grey Wolf Optimization, PI Controller, Grid Tied Photovoltaic System, MATLAB/SIMULINK, STATCOM, Grid Converter, Duty Cycle.

1.INTRODUCTION

The energy sector is now an essential component of organization for the well-being of nations and is also vital for economic development. The power sector in India is extremely changed. In India, conventional electricity production accounts for most power generation sources, with non-conventional generation seeing an increase in demand [1]– [5]. It is necessary to produce high-quality power since power generating is so important. However, there are various power quality problems because of the wide variety of loads. Power engineers and the power industry thus face a difficult problem when it comes to power quality. Many techniques are being used these days to compensate for power quality [6]– [10]. This article uses a grid converter based on GWO as a compensator to improve power quality. A shunt compensator called a Grid Converter (STATCOM) receives its input from a PV system. The Grey Wolf Optimized (GWO) Algorithm based control technique for the converter in a grid-tied photovoltaic system has been demonstrated in this study. A novel optimization technique is suggested for the STATCOM control system to fine-tune the PI Controller. Lastly, this work illustrates how a Grid Converter's GWO-tuned PI controller can improve power quality by lowering THD [10]– [15].

2.GREY WOLF OPTIMIZATION (GWO)

The GWO algorithm mimics the leadership hierarchy and hunting mechanism of grey wolves in nature. Four types of grey wolves such as alpha, beta, delta, and omega are employed. In addition to the social hierarchy of grey wolf's pack hunting is another appealing societal action of grey wolves. The main segments of GWO are encircling, hunting and attacking prey.

2.1 The pseudo code of the GWO algorithm

Initialize the grey wolf population X_i (i = 1, 2, ..., n)

Initialize a, A, and C

Calculate the fitness of each search agent

X_α=the best search agent

X_β=the second-best search agent X_δ=the third best search agent **while** (t < Max number of iterations) **for** each search agent

Update the position of the current search agent

end for

Update a, A, and C

Calculate the fitness of all search agents Update X_α, X_β, and X_δ

t=t+1

end while

return X_α

2.2GWO Topology for Grid Converter

This work presents the Grey Wolf Optimized (GWO) algorithm-based converter controller technique for grid-tied photovoltaic systems. An entirely new optimization technique is suggested for the STATCOM control system to fine-tune the PI Controller. In MATLAB, a 100 KW photovoltaic grid system is simulated. Below is the Block Diagram.

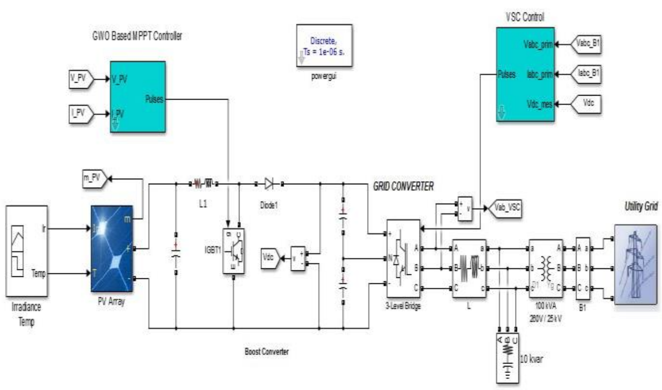

Fig-1: Proposed Model of Grey Wolf Optimization (GWO) based grid converter

A grid converter's development is identical to that of a three-phase inverter. IGBTs are utilized in the Grid Converter as switches. Since IGBTS switches are completely regulated. Six IGBTs have been used in total, indicating that a Grid Converter has three arms altogether—two switches for each arm [16]– [20]. This type has a 100 KW photovoltaic module connected to a 5 kHz 500 V boost converter, which raises the PV module voltage to 500 V and maintains it there no matter what. The Grid Tied Converter has been connected to the Boost Converter. The Voltage Source Converter (level 3) in this model 3 is categorized as a grid converter. The boost converter's constant 500 V DC voltage is transmitted to the grid converter. Through a 100 KVA transformer, the Grid Converter is connected to the Utility Grid.

3.RESULTS AND DISCUSSION

Three Cases with Variable Temperature and Irradiance have been employed to test the proposed model. The two different possibilities have been shown below.

Case 1: PSO based on Grid converter

Case 2: GWO based on Grid Converter

Temperature and IR radiation are the two variables used to test each of the two instances, i.e.,

Pmpp @ 1000 W/m², 25 deg= 100.7 kW @ 273.5 V

Pmpp@ 250 W/m², 25 deg= 24.4 kW @ 265.1 V

Pmpp @ 1000 W/m², 50 deg= 92.9 kW @ 250.2 V

Case 1: PSO based Grid Converter:

In this situation, the PI controller's gain the parameters have been used with the aid of the PSO optimized technique. Since the gain values are tuned values for the PSO algorithm, we can say that the controller is tuned by the PSO algorithm since the PI controller produces the optimum output with the aid of the optimized gain value. The associated outcomes are presented below:

This figure displays the variable temperature and variable irradiance. Mean Power, Duty Cycle, and Mean Voltage. The duty cycle oscillations, mean power, and mean voltage exits. The PV module's output power is 273.5 V when operating at 1000 W/m2 at 25 degrees Celsius, which is the maximum power of 100.7 KW. The PV module's output power is 265.1 V when operating at 250 W/m2 at 25 degrees Celsius, which is the maximum power of 24.4 KW. The maximum power at 1000 W/m2 and 50 degrees Celsius is 92.9 KW, and under these circumstances, the PV module's output power is 92.9kW. The PV module's maximum power at 1000 W/m2 and 50 degrees Celsius is 92.9 KW, and its output power is 250.2 V under these circumstances.

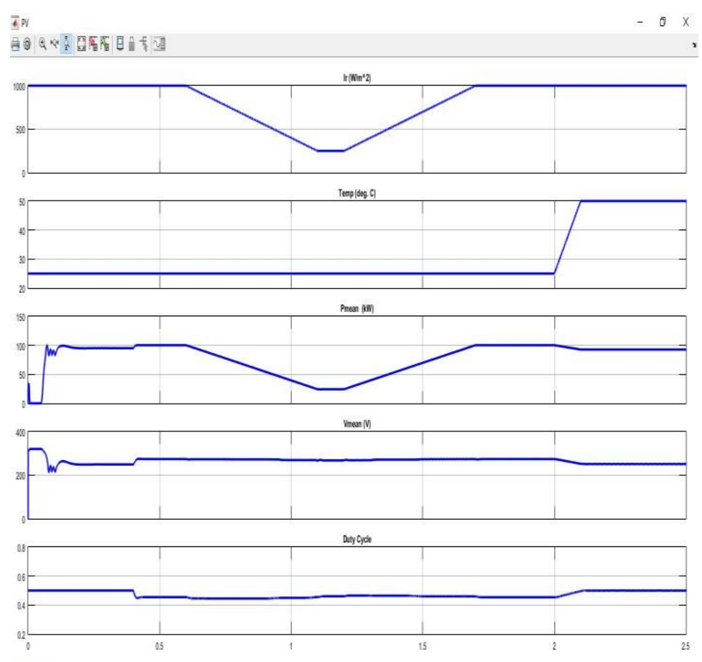

Fig-2: Variable Irradiance, Variable Temperature. Mean Power, Mean Voltage, Duty cycle of proposed model

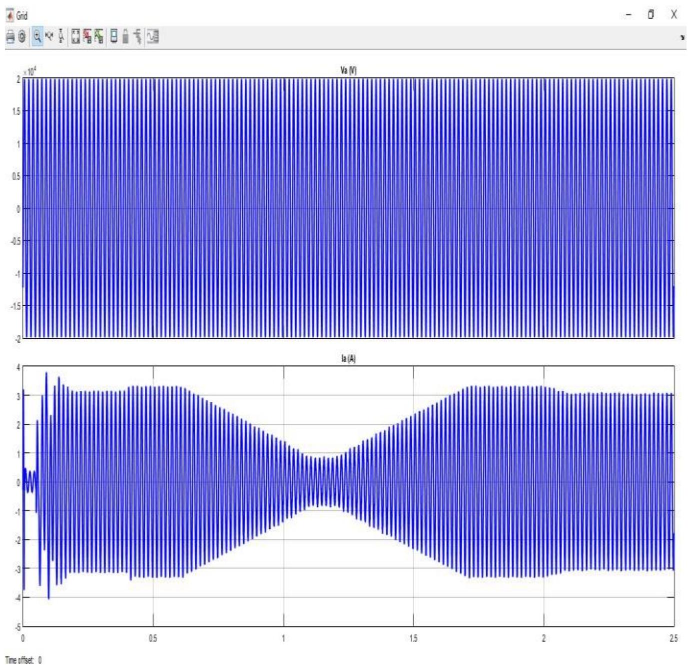

Fig-3: Grid Voltage and Grid Current for the proposed model

The grid voltage maintains constant irrespective fluctuations in temperature and irradiance, as represented by the preceded figure. The THD in this case is 3.29%.

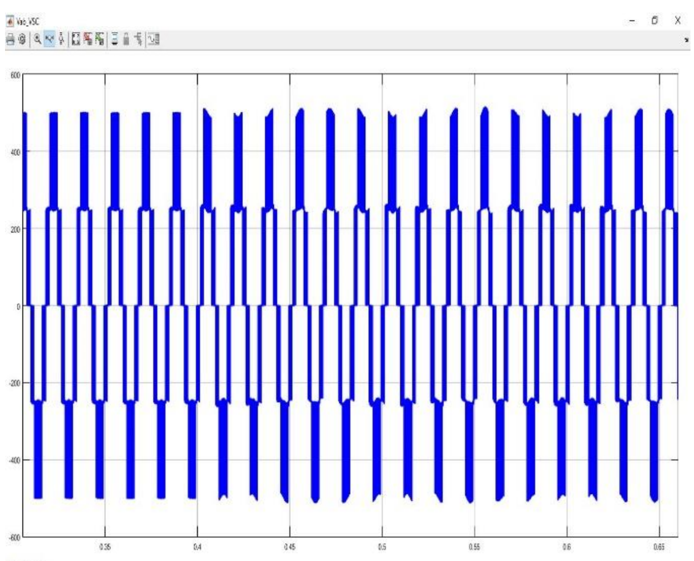

Fig-4: Grid Converter Output Voltage

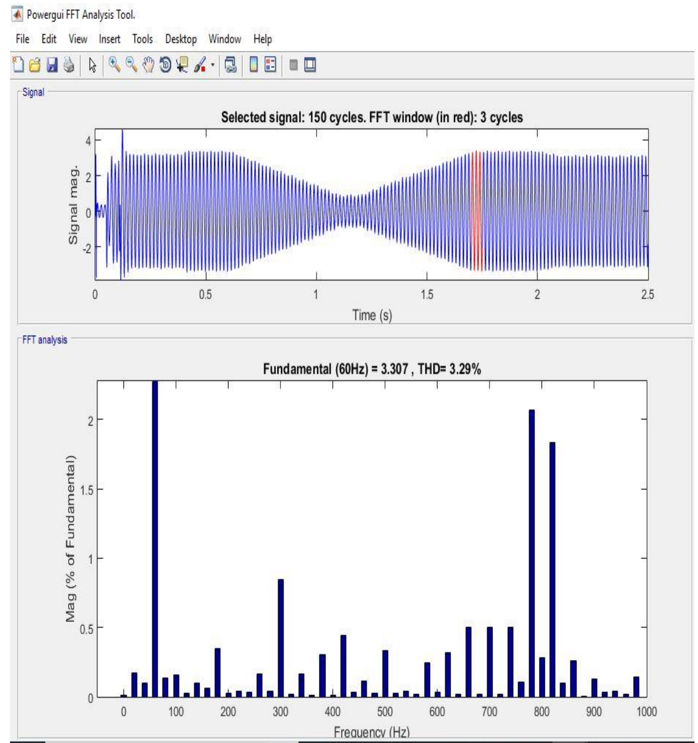

Fig-5: THD analysis of PSO based Grid Converter

Case 2: GWO based Grid Converter

In this situation, the PI controller's gain values are utilized with the aid of the GWO optimized method. Since the gain values are tuned values for the PSO algorithm, we can claim that the controller is tuned by the GWO algorithm since the PI controller produces the optimum output with the aid of the optimized gain value. The matching outcomes are displayed below:

The variable temperature and variable irradiance are highlighted in the following figure. Duty cycle, mean power, and mean voltage. The fluctuations in the mean power, mean voltage, and duty cycle exist. The maximum power at 1000 W/m2 and 25 degrees Celsius is 100.7 KW, and the PV module's output power is 273.5 V under those circumstances. The maximum power at 250 W/m2 and 25 degrees Celsius is 24.4 KW, and under these circumstances, the PV module's output power is 265.1 V. The maximum power at 1000 W/m2 and 50 degrees Celsius is 92.9 KW, and under these circumstances, the PV module's output power is 250.2 V.

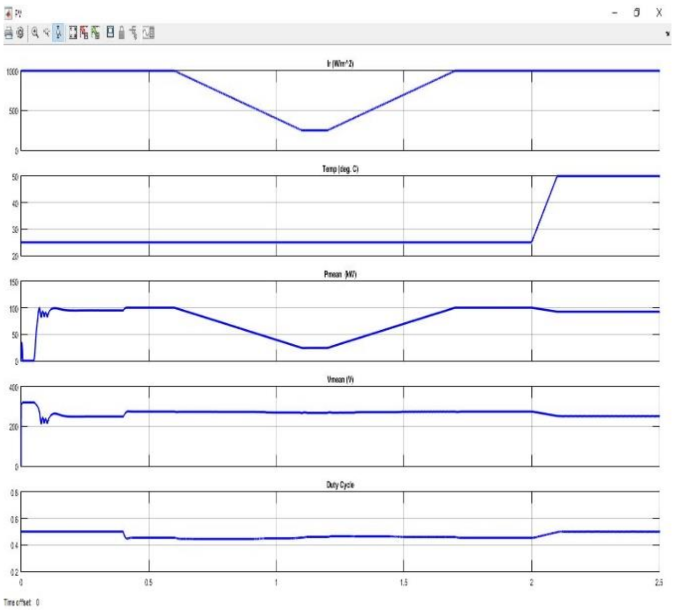

Fig-6: Variable Irradiance, Variable Temperature. Mean Power, Mean Voltage, Duty cycle of proposed model.

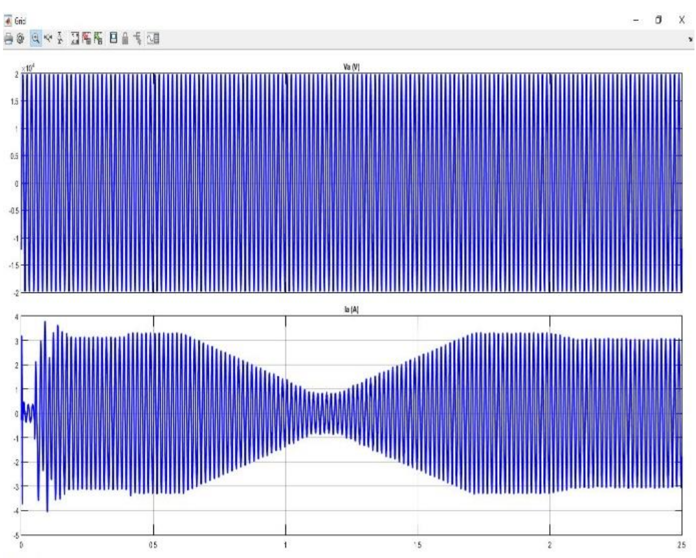

Fig-7: Grid Voltage and Grid Current for the proposed model

Fig-7 shows that grid voltage is constant even though the variable Irradiance and Variable Temperature.

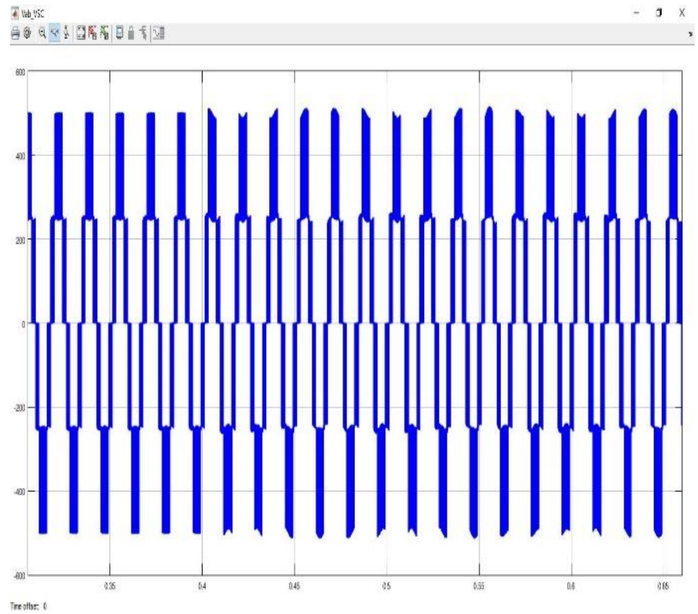

Fig-8: Grid Converter Output Voltage

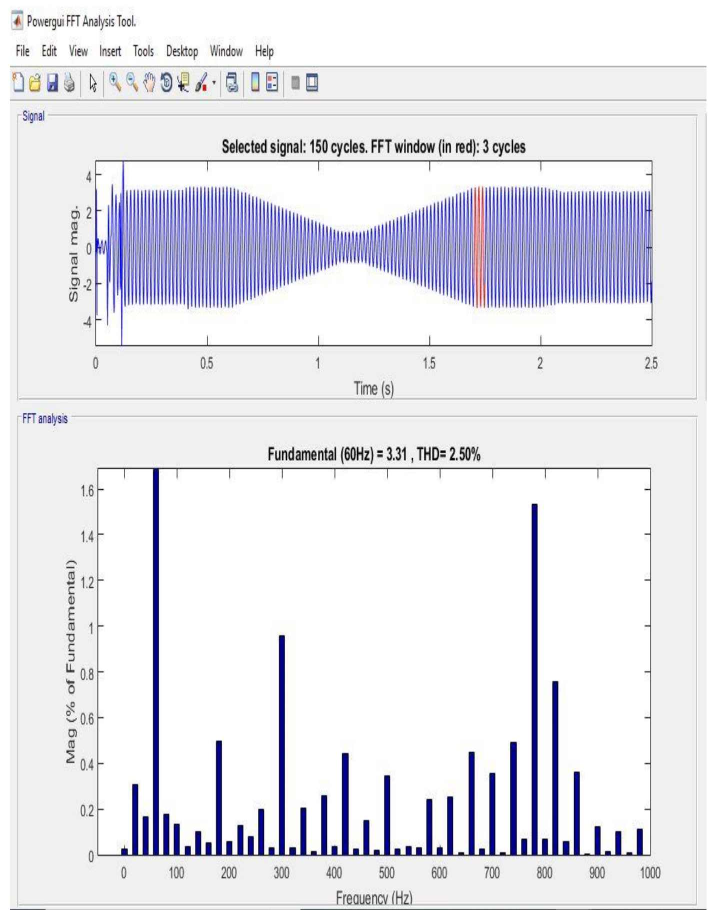

Fig-9: THD analysis of GWO based Grid Converter

The THD in this case is 2.50%.

Table-I: Comparison of THD

Case	Mode	THD
1	PSO based Grid Converter	3.29 %
2	GWO based Grid Converter	2.50 %

From the above comparison a mark reduction in THD from 3.29 % to 2.50% is observed with the proposed Grey Wolf Optimized (GWO) based Grid Converter.

4.CONCLUSION

In this paper, MATLAB/SIMULINK is implemented to model the Grid Converter based on GWO Tuned PI Controller. The most appropriate tuning technique for the PI Controller, depending on the results, is the Grey Wolf Optimization Technique. It is noticeable from the THD analysis that THD has decreased from 3.29% to 2.50%. Consequently, a Grid Converter's THD can be decreased by implementing a GWO-tuned PI controller to improve power quality.

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BIBIOGRAPHIES

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