

DESIGN AND TESTING OF MAXIMUM POWER POINT TRACKING SYSTEM USING ARTIFICIAL NEURAL NETWORK FOR SOLAR PANEL

A N Madan, V. M. Parthasarathy

E-Mail Id: madan.madhu555@gmail.com

Department of Electrical and Electronics Engineering, NITTE Meenakshi Institute Technology, Bengaluru, India

Abstract-The rapid depletion of fossil fuels and rising environmental problems opened a door for renewable energy resources. The mostly used for renewable energy resources solar energy is the one. Due to the higher cost of solar panel efficient operation is to be essential. In this paper the artificial neural network based on MPPT is proposed.

1. INTRODUCTION

Maximum power point tracking (MPPT) is a technique to maximize the power output. Photovoltaic Cells and other similar devices use this technique to get maximum power. Photovoltaic cells have a complex relationship between their operating environment and power they can produce. [1] The power output depends mainly on solar irradiance, temperature and total resistance. Due to nonlinear I-V characteristics, where output power varies with cell voltage it is necessary to develop a mechanism that will harness the maximum power available from sun at all the times.

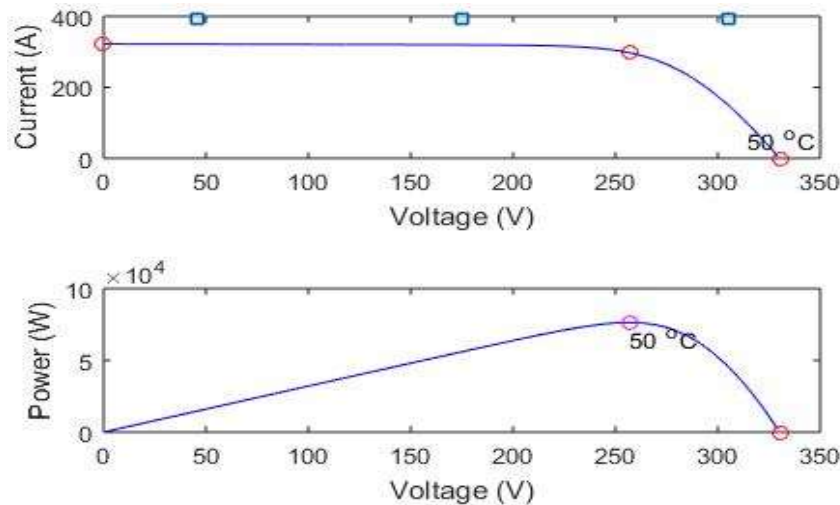


Fig. 1.1 I-V and P-V characteristics of Solar Cell

The point at which is 0 in the P-V curve is called the Maximum Power Point also called as 'knee' point. Classical perturb and observe algorithm approach compares the current operation point and subsequent perturbation point to observe their changes in the power and the controller increases or decreases the PV array output voltage is based on the difference the power. If this difference is positively weighted then duty cycle of converter increases and if negatively weighted then duty cycle of converter must decrease. But if positive and negative weighted error comes subsequently then maximum power is not reached. [2]

Incremental Conductance method has advantages over P&O in that it can determine when the MPPT has reached the MPP, where P&O oscillates around the MPP. Also, the incremental conductance can be track rapidly increasing and also the decreasing irradiance conditions with higher precision than perturb and observe. The disadvantage of this algorithm is the increased complexity. [3]

Constant Voltage algorithm assumes that maximum power point voltage at different irradiance is approximately equal and is around 76% of open circuit voltage.

In last few years artificial intelligence is gaining popularity to track maximum power point. Artificial Neural Network is one of them. The major advantage with this algorithm is that it doesn't need to solve the complex mathematical relation between power output, solar irradiance, solar temperature and total resistance plus the outputs are obtained in a very less time with no oscillations at all. Mathur in his inspiring paper [2] presented a method to

DOI Number: <https://doi.org/10.30780/IJTRS.V04.I06.003>

pg. 20

www.ijtrs.comwww.ijtrs.org

track the maximum power point voltage using artificial neural network. He also simulated the MPPT in Simulink for operating a solar panel which is supplying load using Buck-Boost Converter. However model is simulated using control blocks. In this paper, I used ANN based MPPT to operate the solar panel so that it can provide constant output voltage across the load using Boost Converter.

2. OVERVIEW OF SYSTEM

The proposed system is as below,

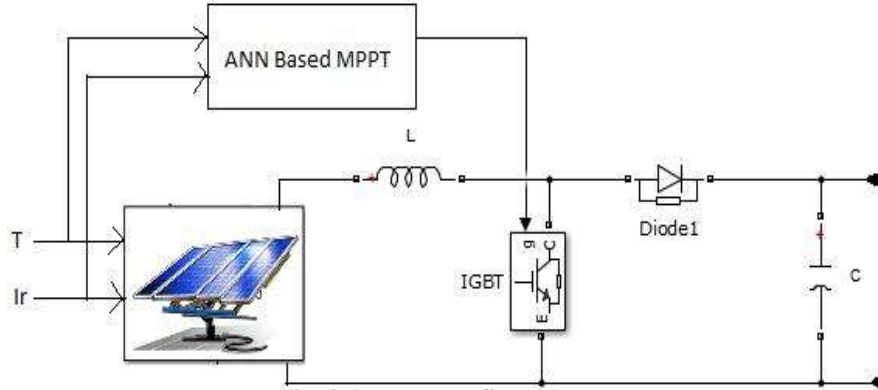


Fig. 2.1 Proposed System

It consists the solar panel, ANN Based MPPT and Boost Converter.

2.1 Solar Panel

The model of PV array is taken form MATLAB/Simulink library whose model number is 1Soltech 1STH-215-P.The specification sheet for this panel is as below.

Table-2.1 Specification Sheet for 1STH-215-P

Parameters	Values
Open circuit Voltage	36.3V
Short Circuit Current	7.84A
Temperature coefficient of Voc	-0.3699%/V
Temperature coefficient of Isc	0.102%/A
Light Generated current	7.8649A
Diode saturation Current	2.9259e-10A
Diode ideality factor	0.98117
Shunt Resistance	313.3991ohm
Series resistance	0.39383ohm

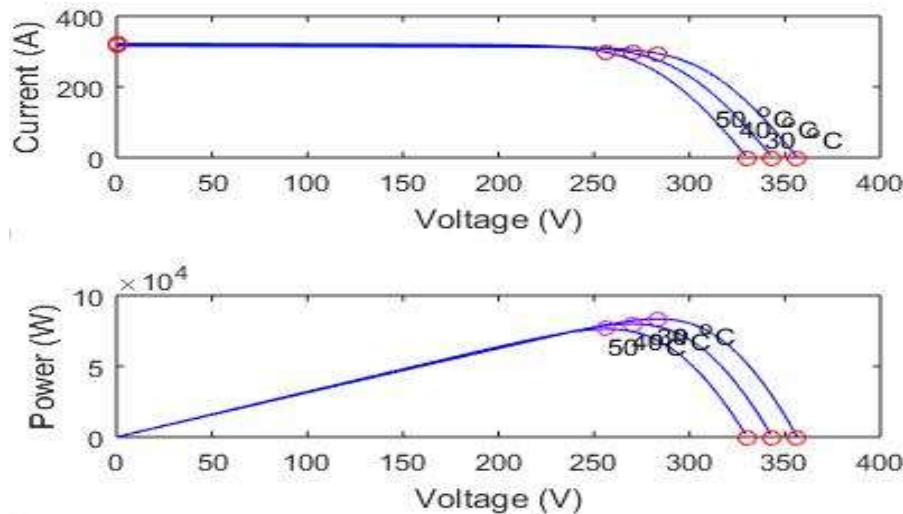


Fig. 2.1 I-V and P-V Curve at Nominal Irradiance (1000W/m^2)

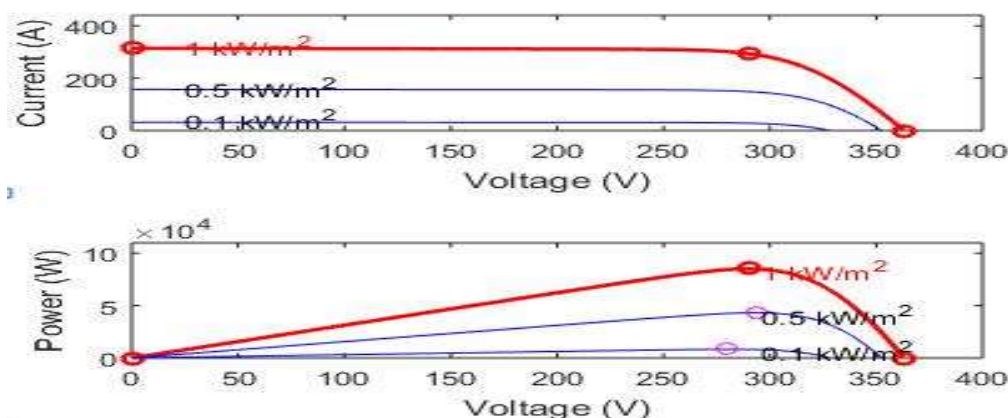


Fig. 2.2 I-V and P-V Curve at Nominal Temperature (25°C)

2.2 ANN Based MPPT

Artificial neural networks (ANNs) are the family of statistical learning models inspired by the biological neural networks and they are used to estimate or approximate the functions that can depend on a large number of the inputs and they are generally unknown. Artificial neural networks are the generally presented by the systems of interconnected the "neurons" which send messages to the each other. The connections have numeric weights that can be a tuned based on the experience, making of the neural nets adaptive to the inputs and capable of learning. [4] The ANN model is developed in MATLAB/Simulink environment. A feedforward based neural network with two neurons in input layer, five neurons in output layer and one in output layer is constructed. The model of network is as below.

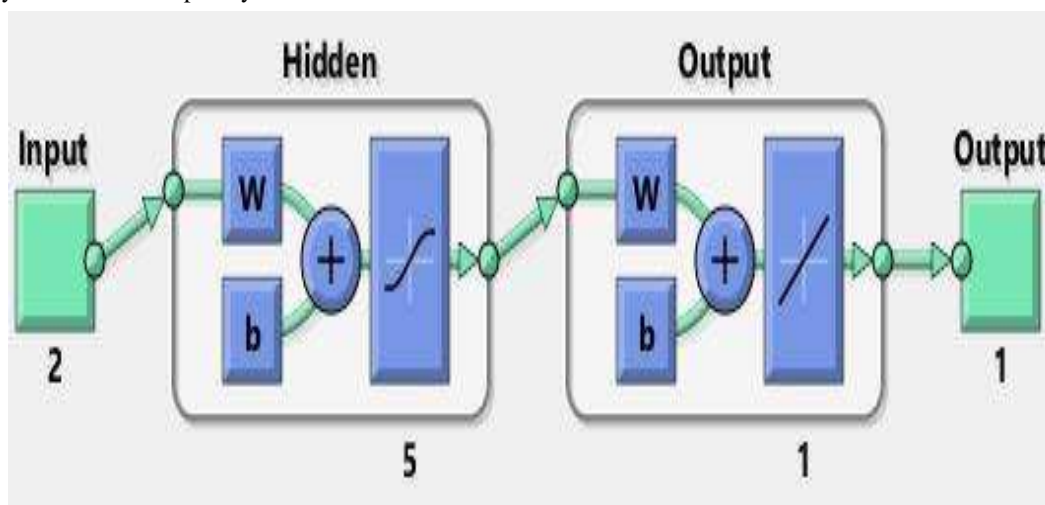


Fig. 2.3 Neural Network Model

The inputs to neural network are temperature and irradiance and the output is the voltage at the maximum power point. In hidden layer of the basis function is weighted linear sum and activation function and tansig. For output layer basis function is linear weighted sum whereas activation function is Linear. The algorithm used is Levenberg-Marquardt. Among 16 data sets 10 data sets are used for training, 4 data sets for validating and 2 for testing. The MATLAB program for developing neural network is,

```
x1=[20 1000;25 1000;30 1000;35 1000;40 1000;45 1000;50
1000;25 200;25 300;25 400;25 500;25 600;25 700;25 800;25
900;25 1000];
```

```
x=x1';
```

```
t1=[296.8;290;283.2;276.6;270;263.4;256.8;287.5;291.1;292
.6;293.3;293.3;292.6;291.9;289.6;290];
```

```
t=t1';
```

```
net = feedforwardnet(5);
```

```
net = train(net,x,t);
```

```
view(net)
```

```
y = net(x);
```

```
perf = perform(net,y,t)
```

DOI Number: <https://doi.org/10.30780/IJTRS.V04.I06.003>

www.ijtrs.com

www.ijtrs.org

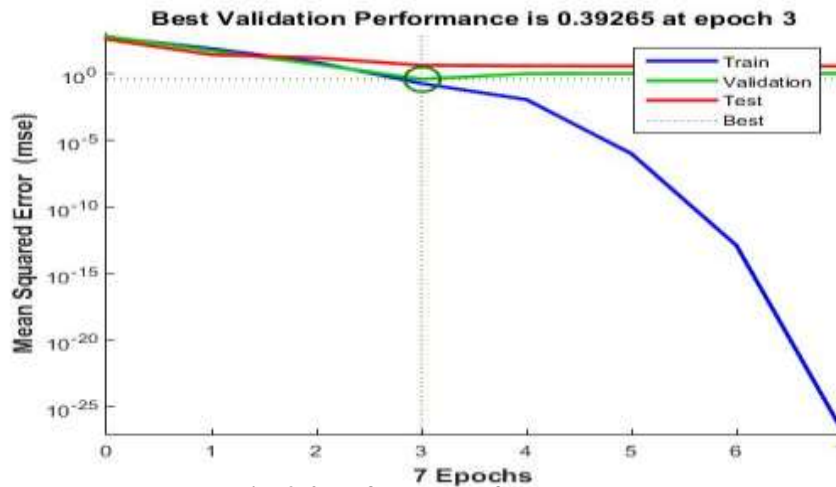


Fig. 2.4 Performance of Neural network

This function is ‘gensim’ is used to produced the Simulink block from above program. Now, so generated output from neural network is compared with the PV cells output voltage and error is passed through PI controller. The output of the PI controller is used as reference signal for generating necessary gating pulses for IGBT.

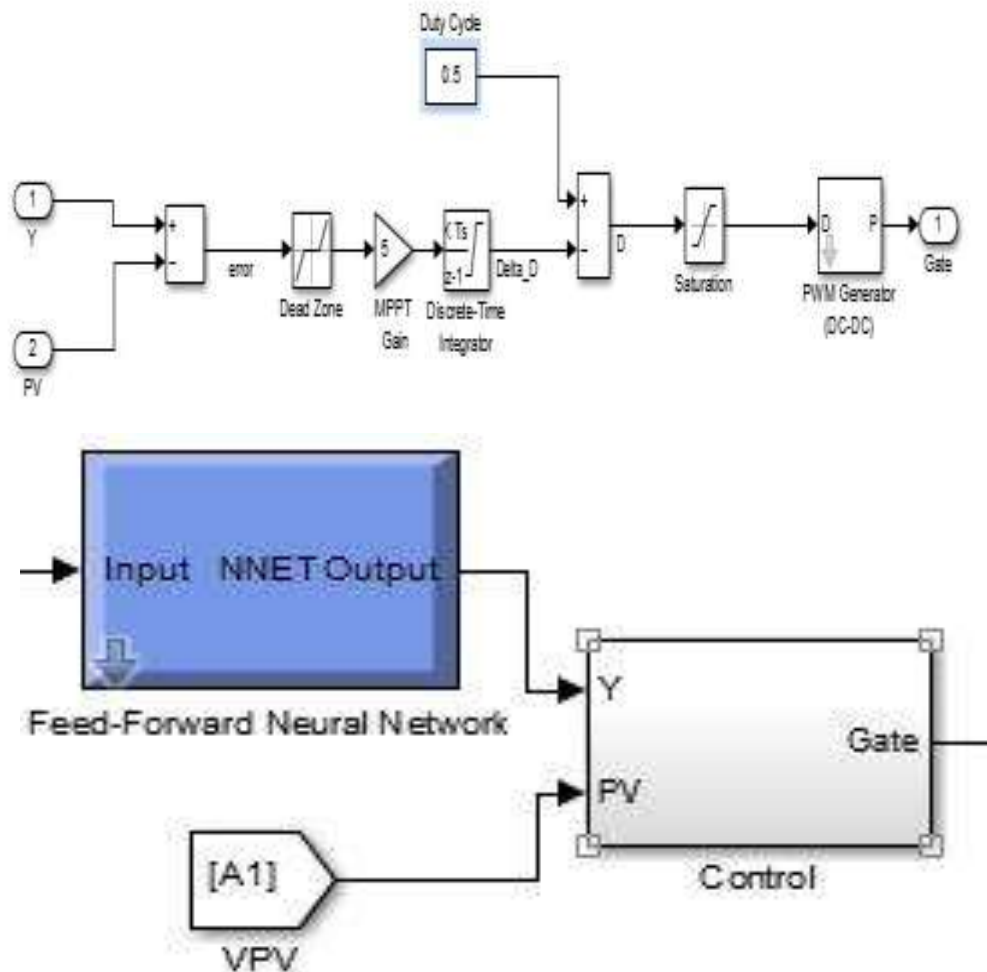


Fig. 2.5 MATLAB/Simulink Block Diagram for ANN Based Controller Block

2.3 Boost Converter

A boost converter is similar to step up chopper i.e. used to step up the input voltage level. The circuit diagram for the Boost regulator using IGBT is as below,

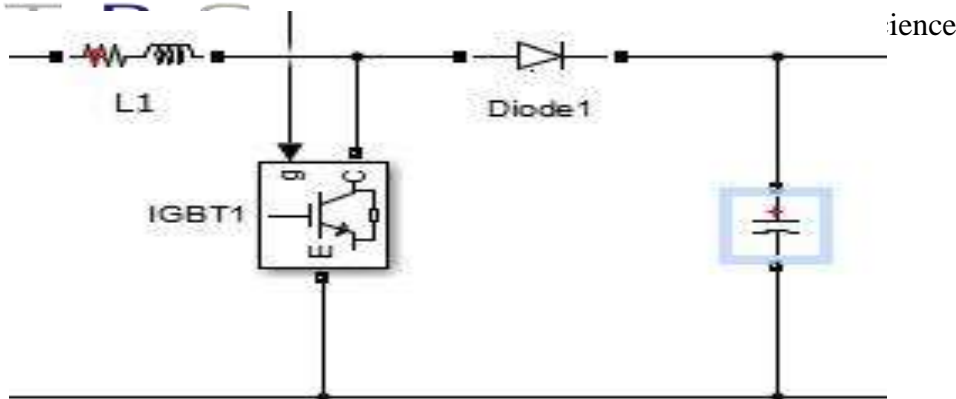


Fig. 2.6 Boost Converter

When the IGBT (Insulated gate bipolar transistor) is on current flows through inductor and IGBT and energy gets stored in the inductor. Now when IGBT is turned off then energy previously stored in the inductor is released through capacitor and load. The amount by which the output voltage gets boosted up depends upon the duty ratio.

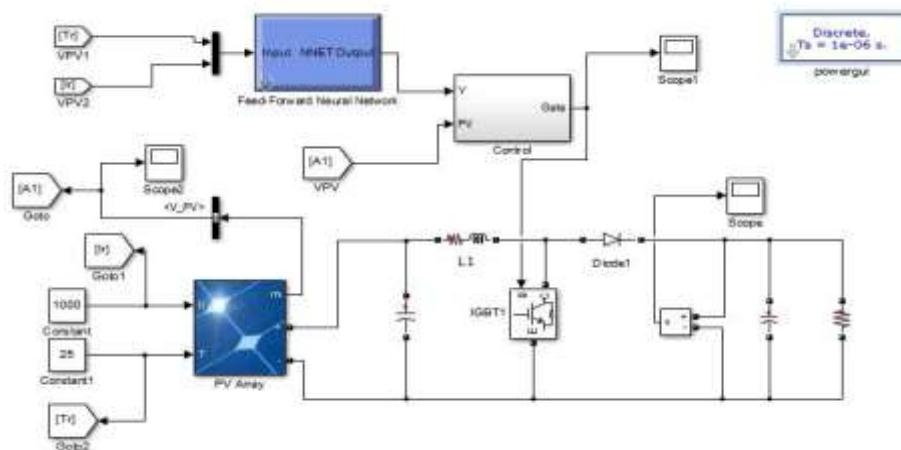


Fig. 2.7 MATLAB/Simulink Block Diagram of Proposed System

The model is simulated for 1 sec. Case I: Without using ANN. In this approach ANN block is replaced by another MPPT controller based on Incremental Conductance method.

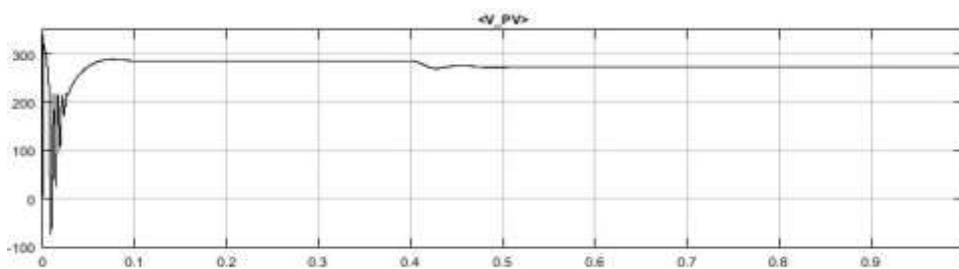


Fig. 2.8 PV Output Voltage

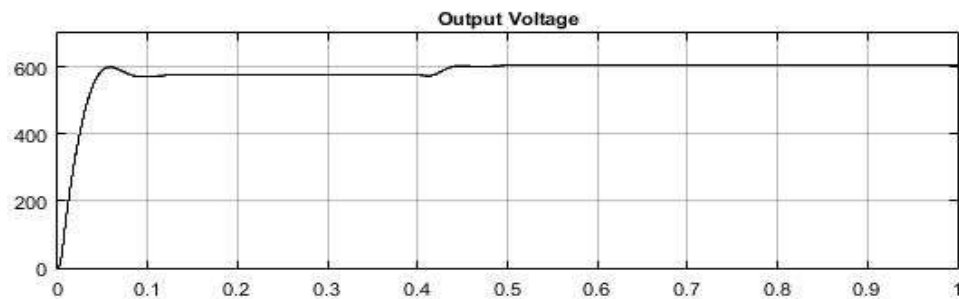


Fig. 2.9 DC Output Voltage After Boost Converter

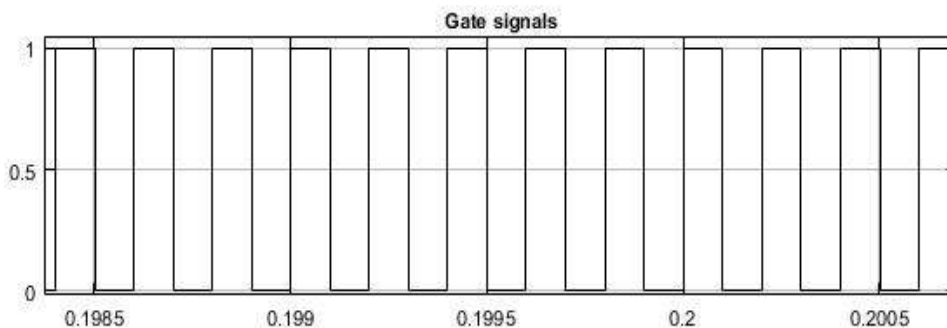


Fig. 2.10 Gate Pulses for IGBT

Case II: Using ANN based MPPT

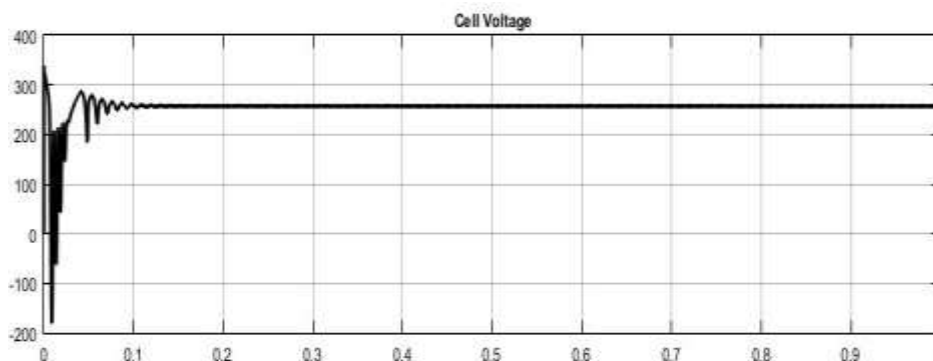


Fig. 2.11 PV Output Voltage

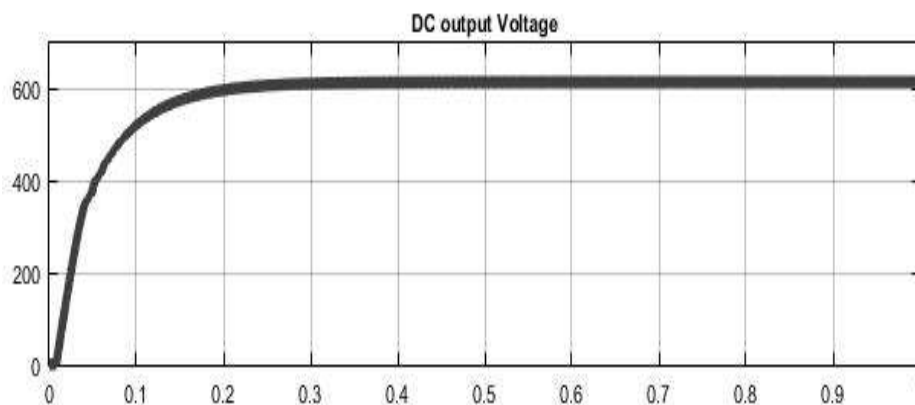


Fig. 2.12 DC Output Voltage After Boost Converter

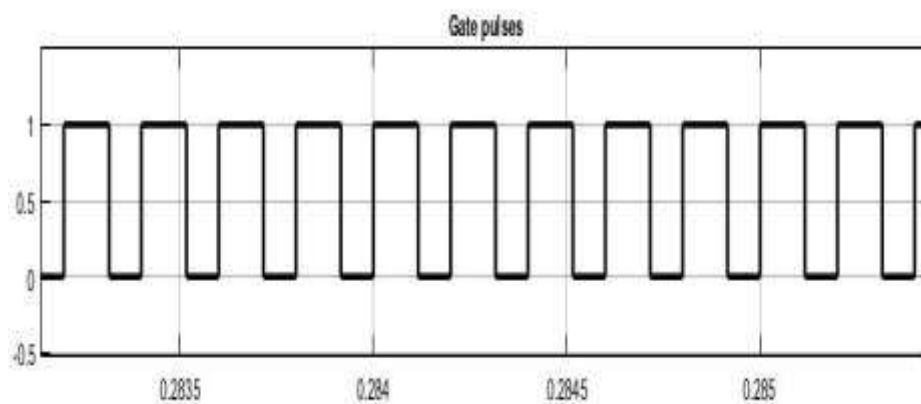


Fig. 2.13 Gate Pulses for IGBT



CONCLUSIONS

The output voltage using the ANN based on the MPPT controller is more smooth and it contained lesser oscillations. The controller is more robust and fast in nature. In this paper only 16 number of data sets are used but if large number of data sets is used to train the network then still more robust and accurate controller can be made.

REFERENCES

- [1] https://en.wikipedia.org/wiki/Maximum_power_point_tracking.
- [2] Mathur, D., “Maximum Power Point Tracking with Artificial Neural Network” International Journal of Emerging Science and Engineering (IJESE) ISSN: 2319–6378, Volume-2, Issue-3, January 2014
- [3] Atallah, A.H., Abdelaziz, A.Y., and Jumaa, R.S., “Implementation of perturb and observe mppt of pv system with direct control method using buck and buck boost converter” An international Journal (EEIEJ), Vol. 1, No. 1, February 2014.
- [4] https://en.wikipedia.org/wiki/Artificial_neural_network.