ANN based Maximum Power Point Tracker for a Standalone PV System

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Outline

- Artificial Neural Network model for Maximum Power Point Tracking is developed using TensorFlow.
- Standalone PV system has been mathematically modelled using SciPy.
- The complete working of the system is analysed and simulated using Python.

MPPT?

- MPPT or Maximum Power Point Tracking is an algorithm used for extracting maximum available power from PV module under certain conditions.
- The output of solar module is function of solar irradiance and temperature.
- Maximum Power Point Trackers are installed in order to save energy and to increase the efficiency of the system.

MPPT?

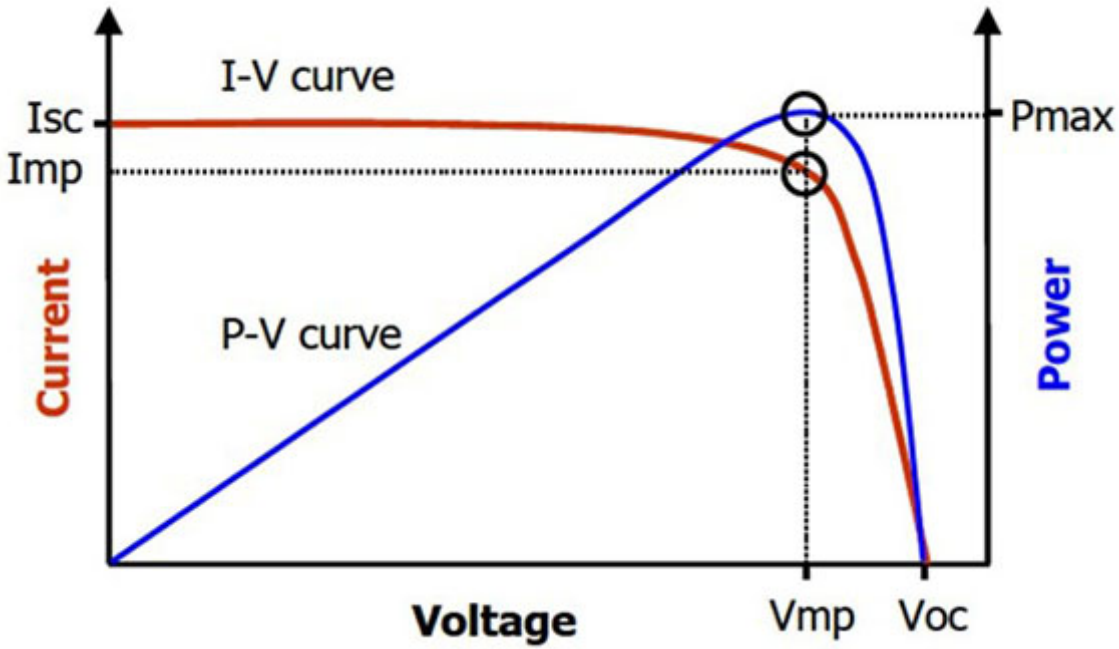
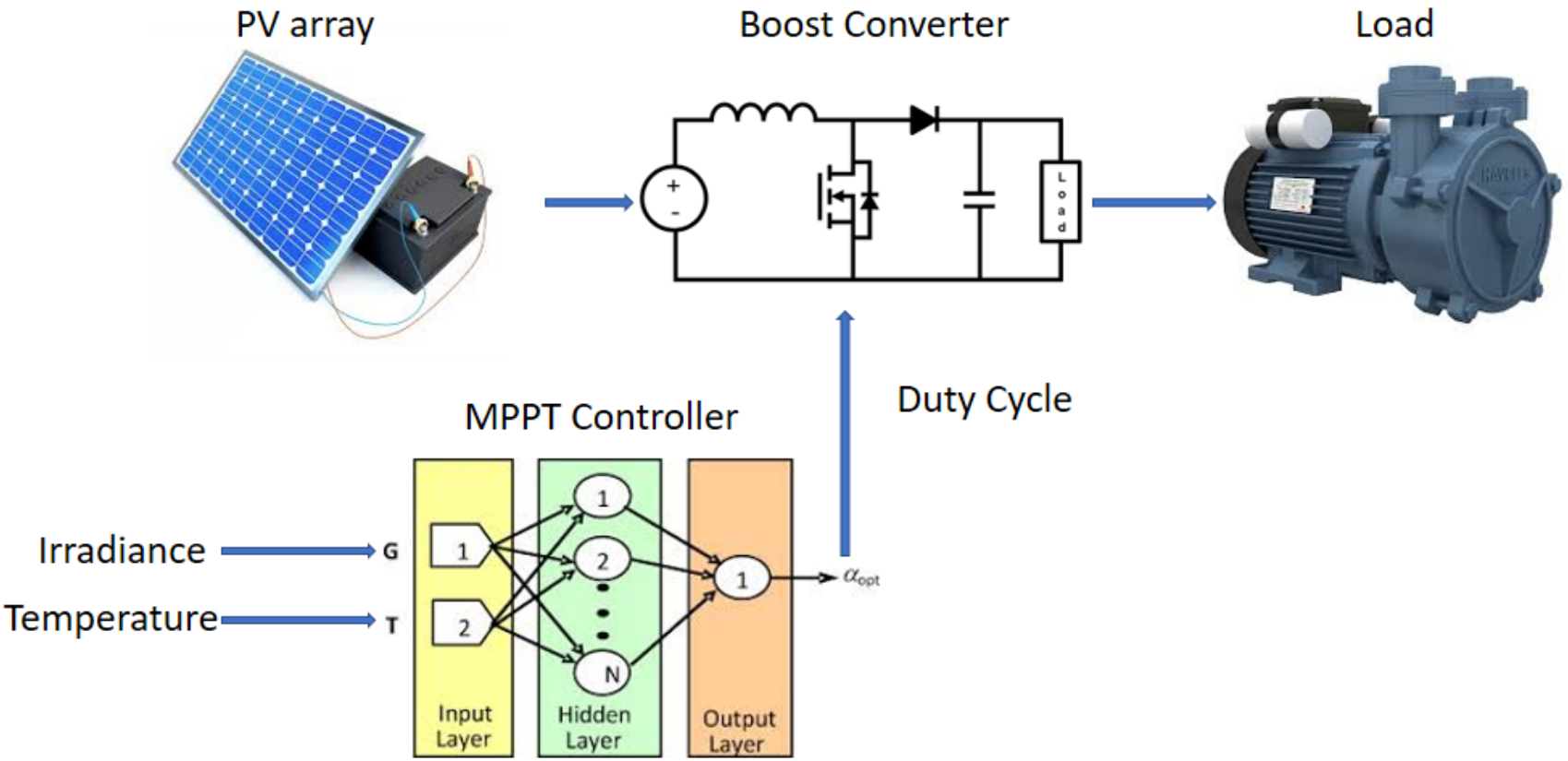


Figure: Maximum Power Point

Optimised Photovoltaic Generator using MPPT Controller



System Equations

- **PV array:Voltage and Power**

$$V_{array} = 54.68 ln(\frac{I_{ph} - I_{array} + 0.005}{0.005}) - 3.74 I_{array} .....(1)$$

$$P_{array} = 54.68 I_{array} ln(\frac{I_{ph} - I_{array} + 0.005}{0.005}) - 3.74 I_{array}^2 .....(2)$$

where,

V_{array}=array output voltage

I_{array}=array output current

P_{array}=array output power

I_{ph}=Variable photo-current proportional to solar insolation

System Equations

- **Boost Converter**

$$\frac{di_L}{dt} = -(\frac{1-s}{L})V_c + (\frac{1}{L})V_s \ldots\ldots\ldots (3)$$

$$\frac{dV_c}{dt} = (\frac{1-s}{c})i_L + (\frac{-1}{RC})V_c \ldots\ldots\ldots (4)$$

where,

s=Switching state

V_s=Input to boost converter

R=Resistance

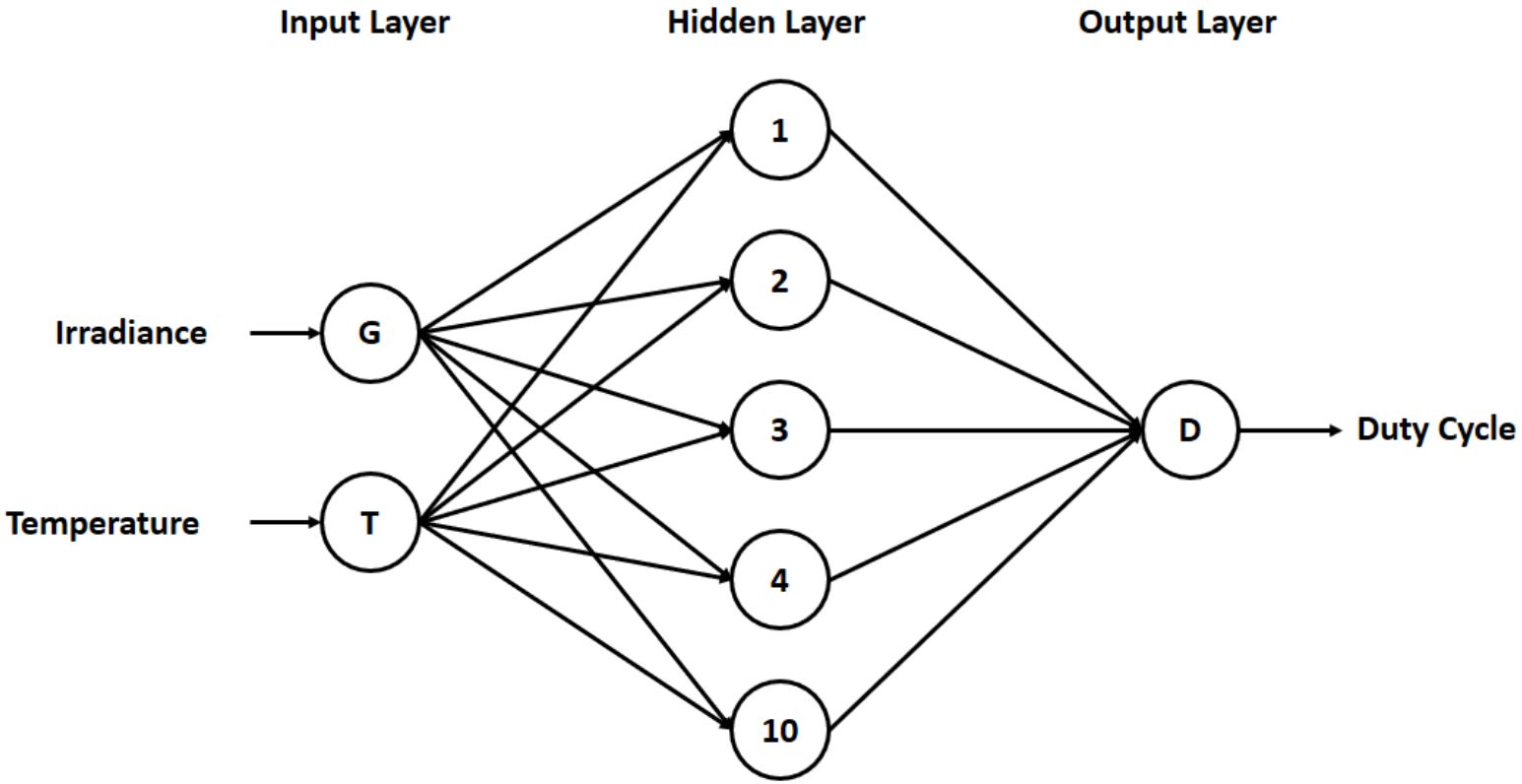
L=Inductance

C=Capacitance

Training of Neural Network

- The training data is obtained from the simulation of the PV array feeding the boost converter in Matlab / Simulink.
- The duty cycle at MPP for a range of irradiance and ambient temperature conditions are recorded which are then used as the training data for ANN.
- The algorithm used for training is back-propagation.

Architecture of proposed Neural Network Controller



Results

Insolation	Vmax(V)	Imax(A)	Calculated D	Predicted D
100	280	6.68	0.857	0.849
75	271.97	4.988	0.837	0.829
50	258.48	3.297	0.80	0.78
25	231.85	1.6173	0.75	0.743

Results

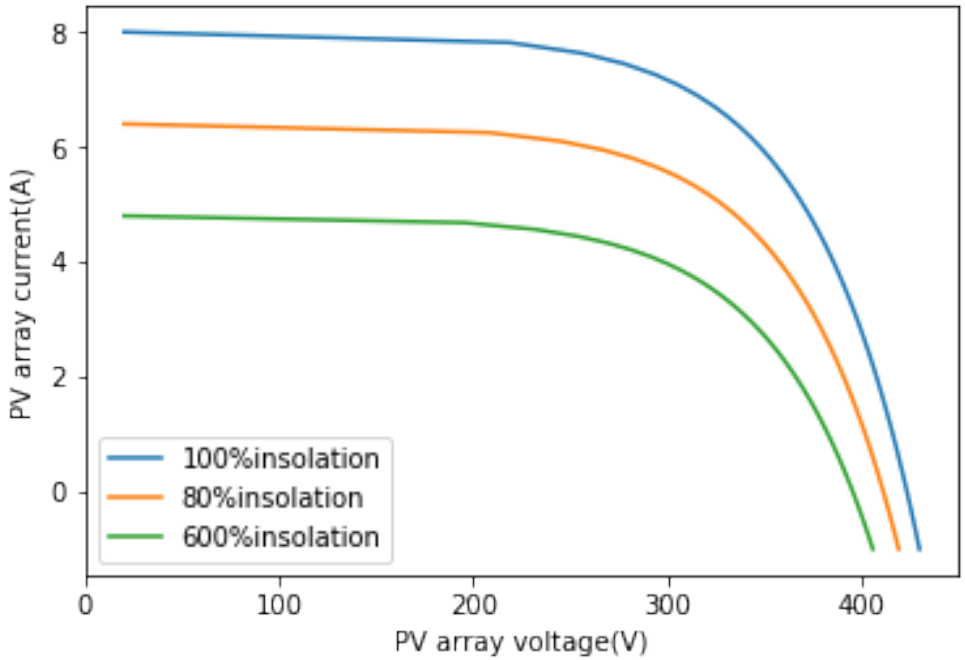


Figure: VI characteristics of PV panel for different insolation levels

Results

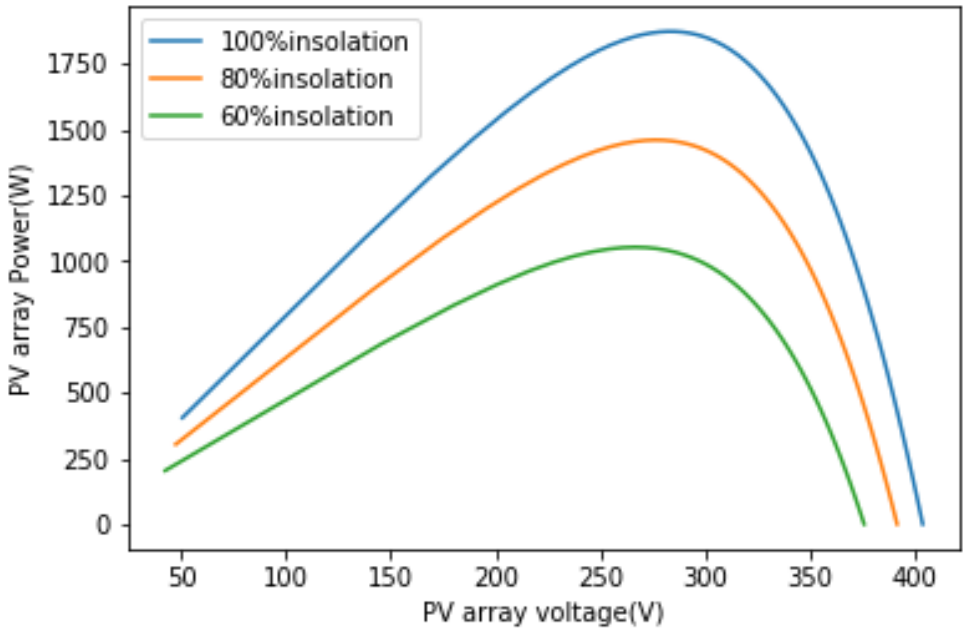


Figure: PV characteristics of solar panel for different insolation levels

Results

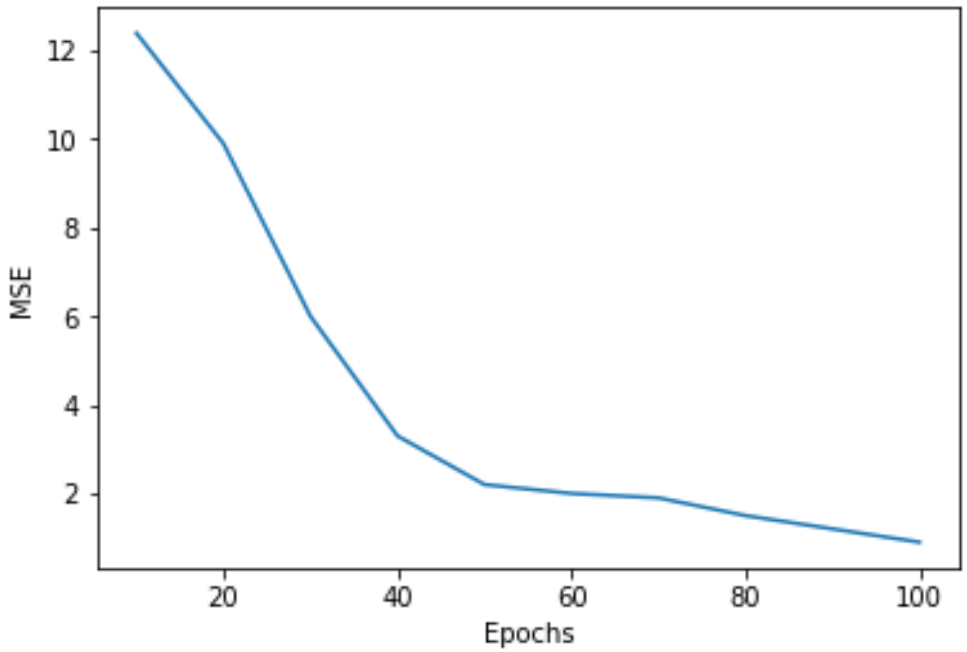


Figure: Epoch Vs Mean Square Error

Boost converter output at 80percent insolation

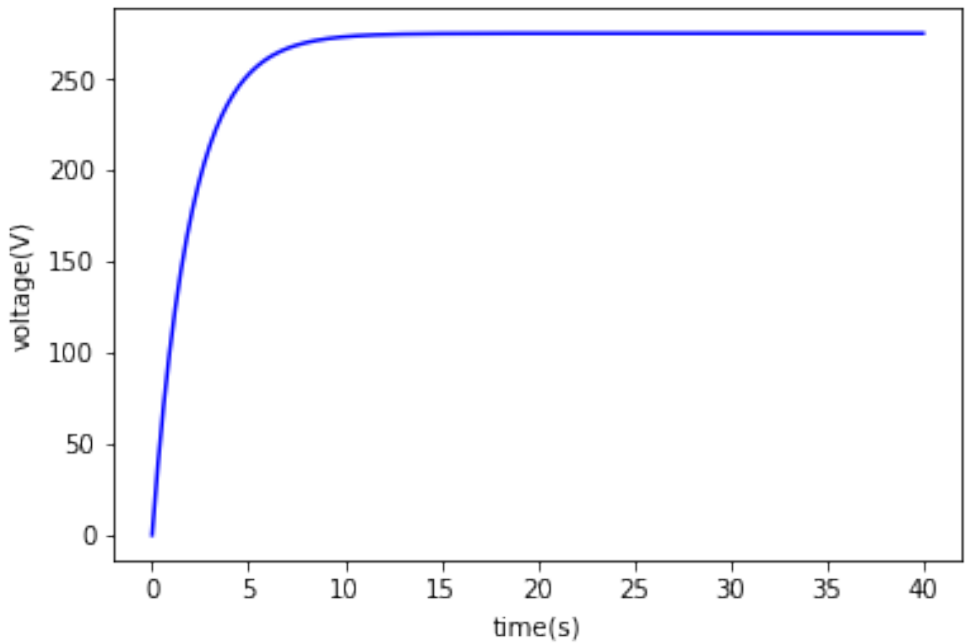


Figure: Output voltage of boost converter in volts

Boost converter output at 80percent insolation

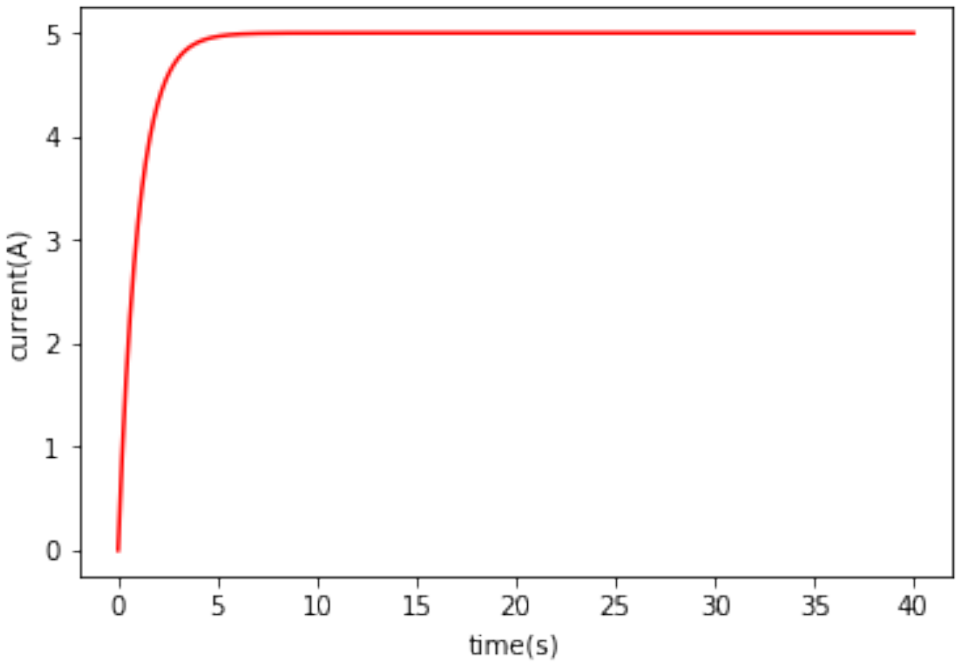


Figure: Load current in Amperes

References

- S. Leva, A. Dolara, F. Grimaccia, M. Mussetta, E. Ogliari, Analysis and Validation of 24 hours Ahead Neural Network Forecasting of Photovoltaic Output Power, Int. Rev. Electr. Eng. 7 (1) (2014), pp. 34543460.
- Bastidas-Rodriguez, J.D., Franco, E., Petrone, G., Andrs Ramos-Paja, C., Spagnuolo, G., Maximum Power Point Tracking Architectures for Photovoltaic Systems in Mismatching Conditions: A Review, IET Power Electron., 2014, 7, (6), pp. 13961413.
- TensorFlow and deep learning,Google cloud platform

THANK YOU