Modelling and Parameter Identification Using Reduced *I-V* Data

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1. Background

- ❖Photovoltaic (PV) systems are developing steadily due to the current trend worldwide.
- ❖Considering the viable growing demand in PV systems, it is imperative to understand the factors leading to a change in the performance.
- ❖Hence, the need for reliable real time parameter identification of PV modules.

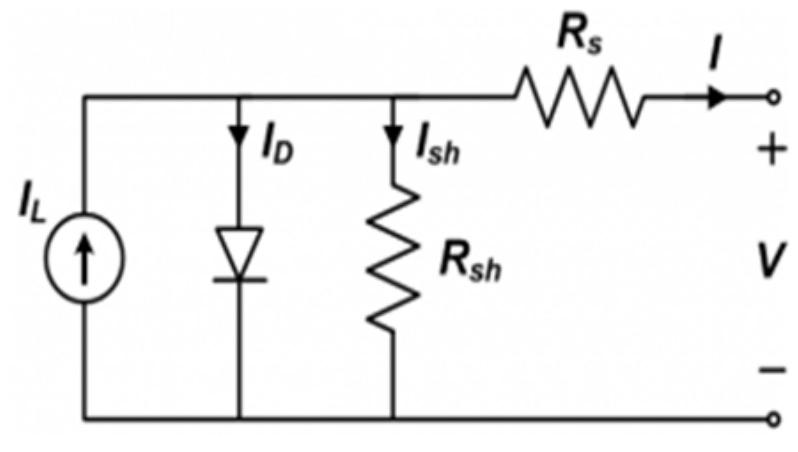

Figure 1: One Diode Model

2. Motivation

- ❖In recent papers published, only a few I-V coordinates are required to solve the four-parameter PV cell model for Maximum Power Point Tracking (MPPT) [1,2,3].
- ❖This application is required mainly for the practical operation of PV panels, especially for the panels used in a satellite in outer space, as a full I-V scan is not achievable.
- ❖Lim et al. [4] transforms the non-linear I-V curve into a linear systems output, where five unknown parameters (a, IL, Io, Rs, Rsh) are obtained from an I-V curve, reducing the search space from five to one.
- ❖This work integrates the concept of using fewer I-V data points for parameter identification with the linear method in [4].
- ❖Obtained parameters are used to plot the Power-Voltage (P-V) curve, which is capable of replacing MPPT algorithms.

3. Objectives

- ❖Parameter identification using Linear Identification method in [4].
- ❖Investigation on the accuracy of the maximum power using the obtained parameters from the one diode model in Figure 1.
- ❖Evaluation of root mean square error (RMSE) of the identified I-V curve and maximum power error (MPE) of the identified P-V curve.

4. Parameter identification Using Linear Identification Method

The non-linear I-V curve is transformed into a linear system output by:

- ❖ Linking the model parameters with the linear differential equation
- ❖Integral-based system identification to identify the parameters.

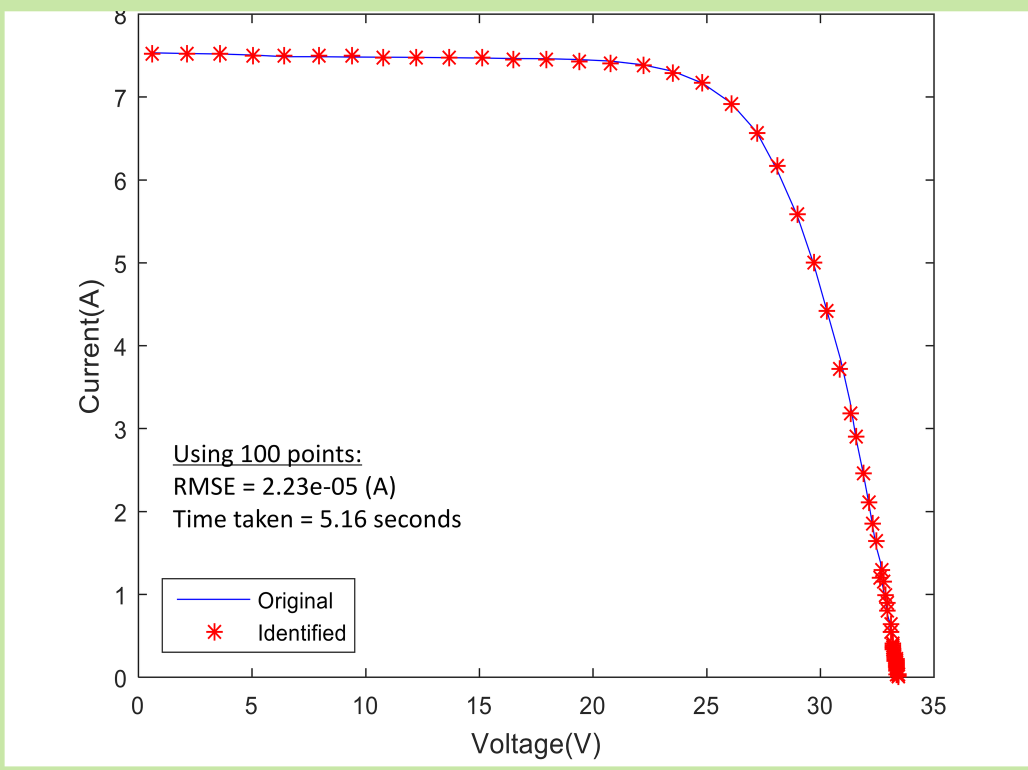

Figure 2: Comparison of original & identified parameters

The calculated RMSE= 2.23e-05 (A), which is very low, as shown in Figure 2..

5. Parameter identification with fewer I-V data points

The number of I-V points used for parameter identification is reduced from the total I-V data of one hundred points to only six points. In this case, the indexes of the six points selected are 1, 8, 14, 19, 23 and 31.

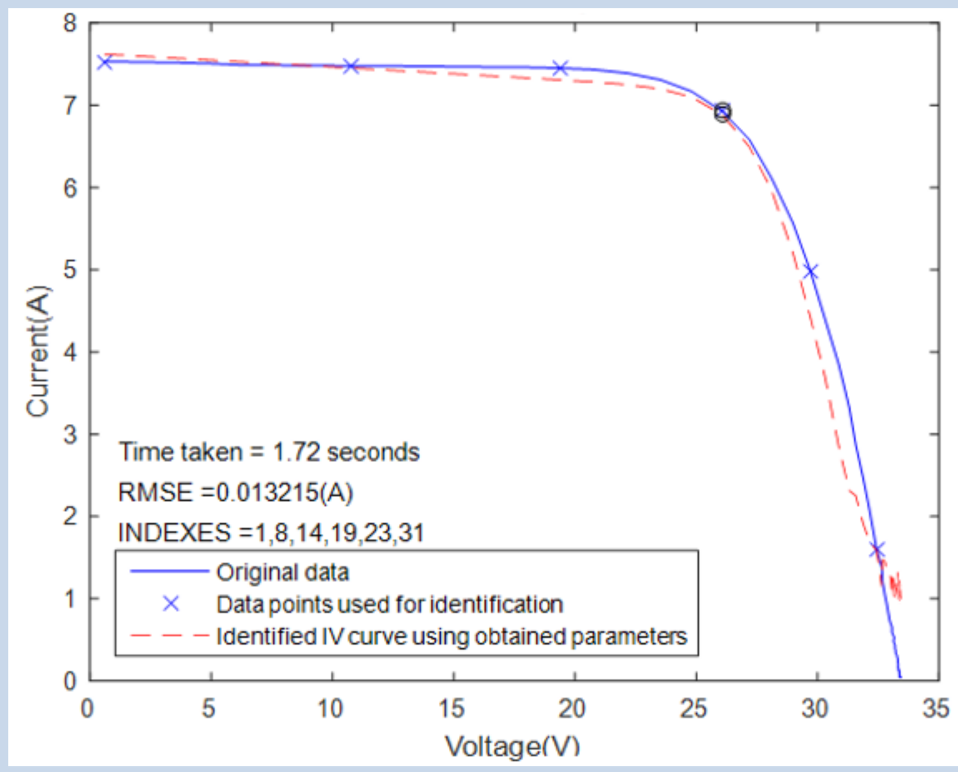

Figure 3: Comparison of original & identified parameters with reduced points

The RMSE equates to 0.0132 (A), as shown in Figure 3.

6. Identification of Maximum Power Point

The P-V curve is plotted using the parameters obtained in Table 1.

Table 1: Parameters obtained through integral based system identification

Parameters	a (V)	I_L (A)	I_O (A)	R_S (Ω)	R_{SH} (Ω)
Values	1.18	7.62	1.93e-10	0.56	60.53

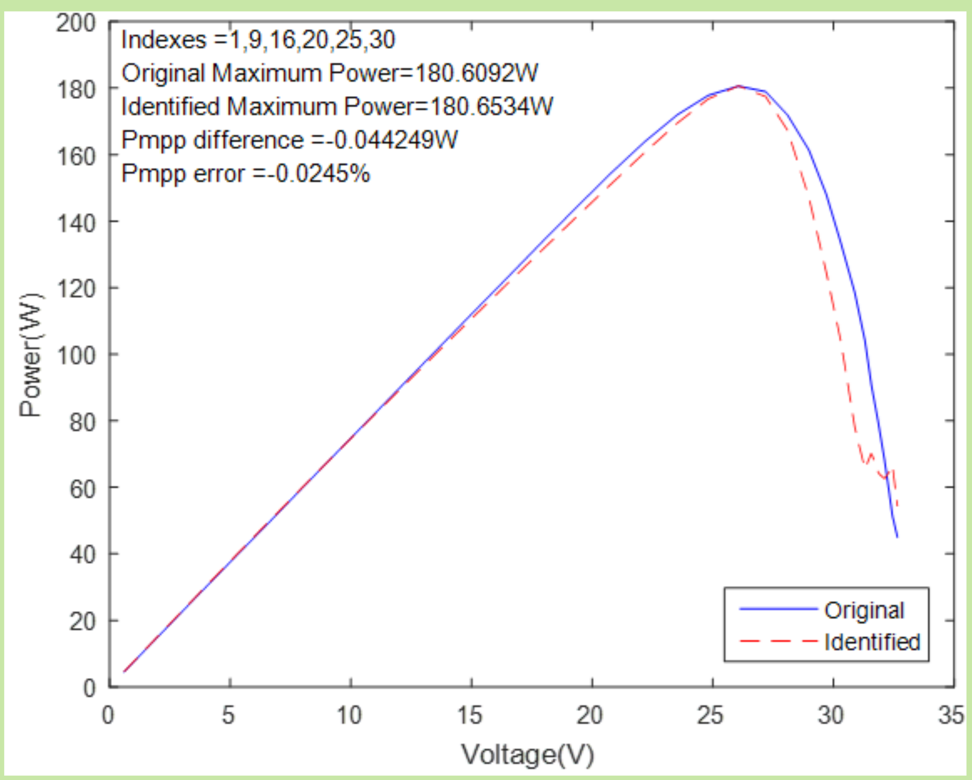

Figure 4: Comparison of original & identified P-V curves

The MPE is 0.0245%, as shown in Figure 4.

7. Conclusions

- ❖Reduced number of points for parameter identification
- ❖Proposed configuration of six I-V points
- ❖Low RMSE from identified I-V Curve
- ❖Low MPE from identified P-V Curve
- ❖Computational time shortened by 2.76 times.

References:

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2. J. M. Blanes, F. J. Toledo, S. Montero and A. Garrigós, "In-Site Real-Time Photovoltaic I–V Curves and Maximum Power Point Estimator," IEEE Transactions on Power Electronics, vol. 28, no. 3, pp. 1234 - 1240, 2012.
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