Data Collection Method

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1 PV System Model

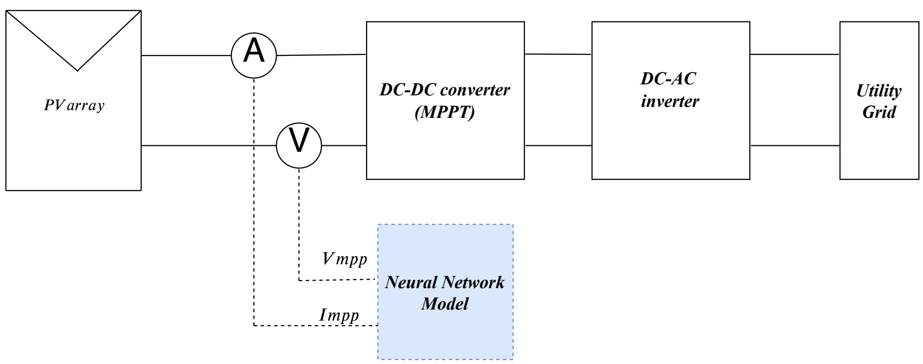

Figure 1: Proposed PV system model.

As shown in Figure 1, the PV system model consists of:

- PV array
- DC-DC converter with Maximum power point tracking algorithm (MPPT)
- Inverter
- Utility grid

The PV inverter absorbs the maximum power from the PV array using MPPT algorithm, and feeds the power into utility grid. Voltage and current at maximum power point will be collected and then passed to Neural Network Model as input.

1.1 PV array

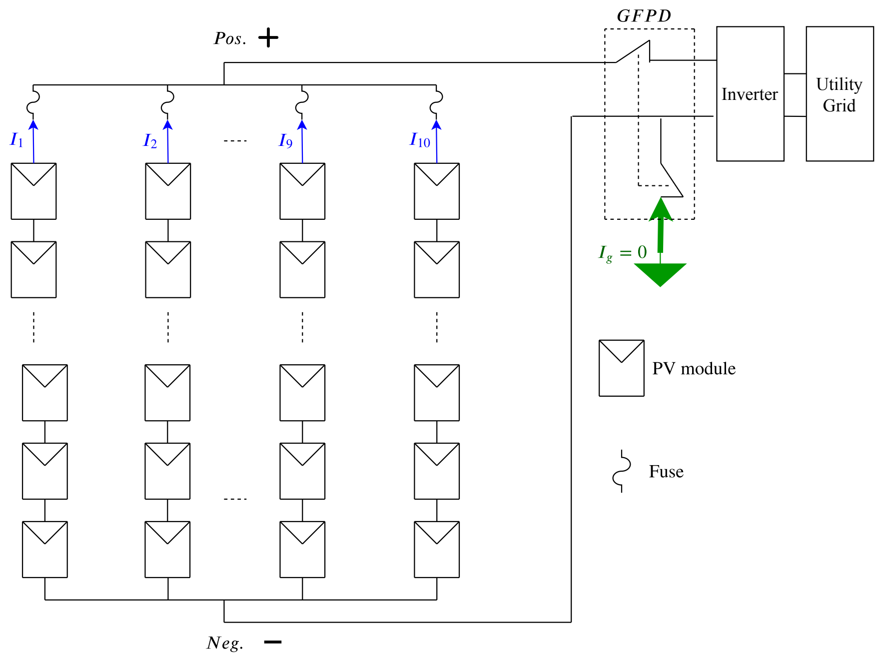

Figure 2: The configuration of the PV array.

As shown in Figure 2, the PV array comprised of 10 × 10 PV modules, which are 10 strings in parallel and 10 modules in series per string.
The main parameters of each PV module at standard test conditions are as follow:

- The maximum power $P_{max} = 225.12$W
- The open-circuit voltage $V_{OC} = 34$V
- The voltage at the maximum power point $V_{mpp} = 28$V
- The short-circuit current $I_{SC} = 8.54$A
- The current at the maximum power point $I_{mpp} = 8.04$A

2 Simulation scripts

The simulation will be conducted by using Matlab/Simulink 2019a and following three conditions:

- Normal condition
- Line-to-line fault
- Shading condition

Simulation parameters:

- Simulation time: 1 second.
- Sampling time: $5e^{-5}$ second.

Simulation conditions:

- Irradiance changes from 600W/m^2 to 1000W/m^2 with step change of 50W/m^2.
- Temperature changes from 20^oC to 40^oC by 1^oC.

2.1 Normal condition

In the normal condition, the setting of the system follows exactly as the simulation scripts mentioned above.

2.2 Line-to-line fault

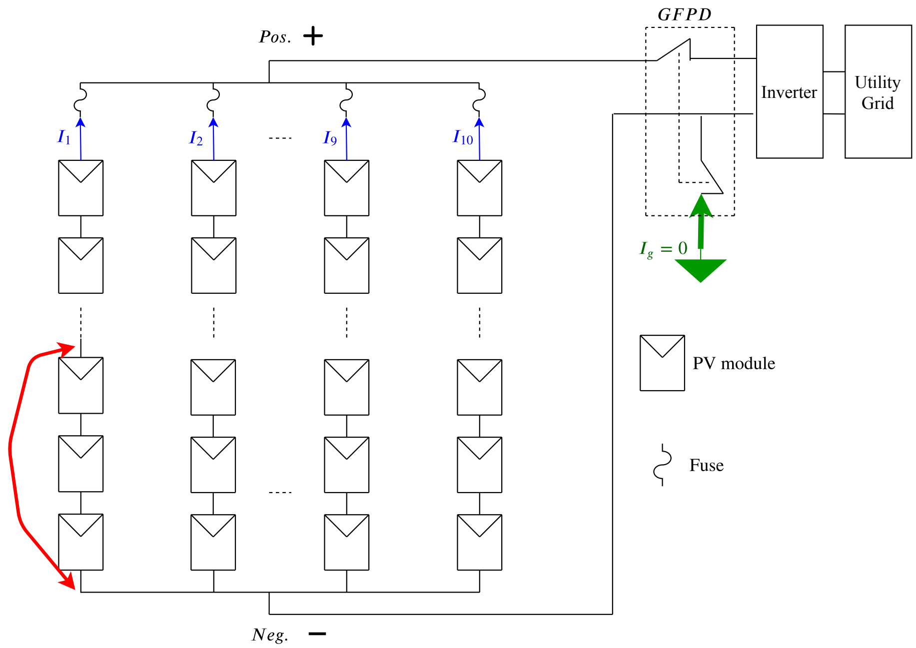

Figure 3: Line-to-line fault in the simulated PV system

In line-to-line fault condition, 3 modules in the faulted string are shorted, which means that there are only 7 active modules. This is defined as 30% location mismatch. In this thesis, the only one faulted string is considered. Compared with normal condition, I_{mpp} under line-to-line fault is slightly reduced , but V_{mpp} is significantly decreased.

2.3 Shading condition

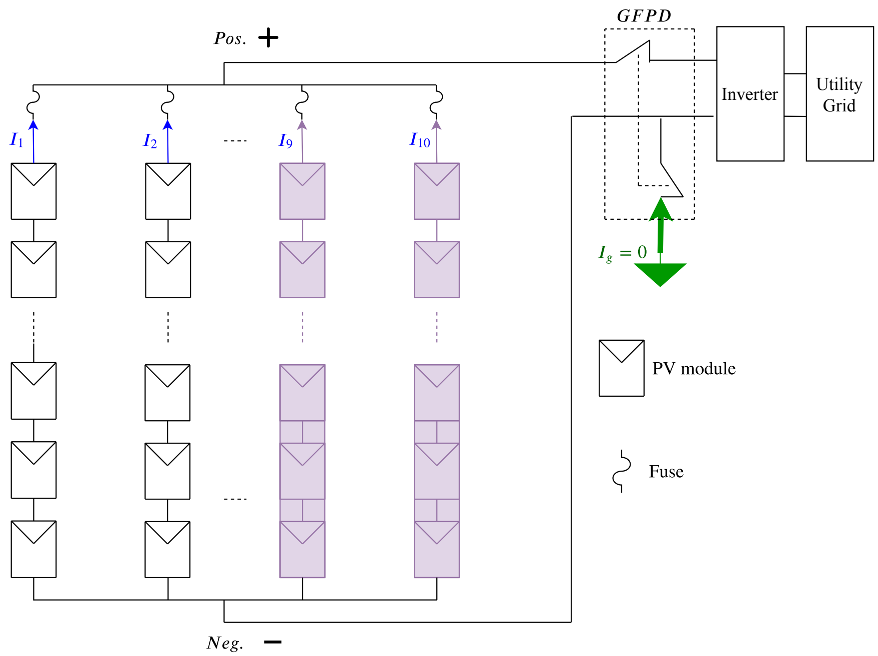

Figure 4: PV system under partial shading condition.

In this condition, 70% of the whole PV system is shaded, and the shaded modules will receive less irradiance than others, in specific is $600W/m^2$. The V_{mpp} of shading condition remains the same as the one in normal condition. But I_{mpp} is reduced proportionally by the number of shaded modules.

3 Data pre-processing

To better visualize and identify PV faults, The V_{mpp} and I_{mpp} will be normalized following equations :

$$V_{norm} = \frac{V_{mpp}}{N_S \times V_{oc}} \tag{1}$$

$$I_{norm} = \frac{I_{mpp}}{N_P \times I_{sc}} \tag{2}$$

Where :

- N_S is the number of modules in series per string
- N_P is the number of strings

The normalized data is now in range (0;1) as depicted in Figure 5:

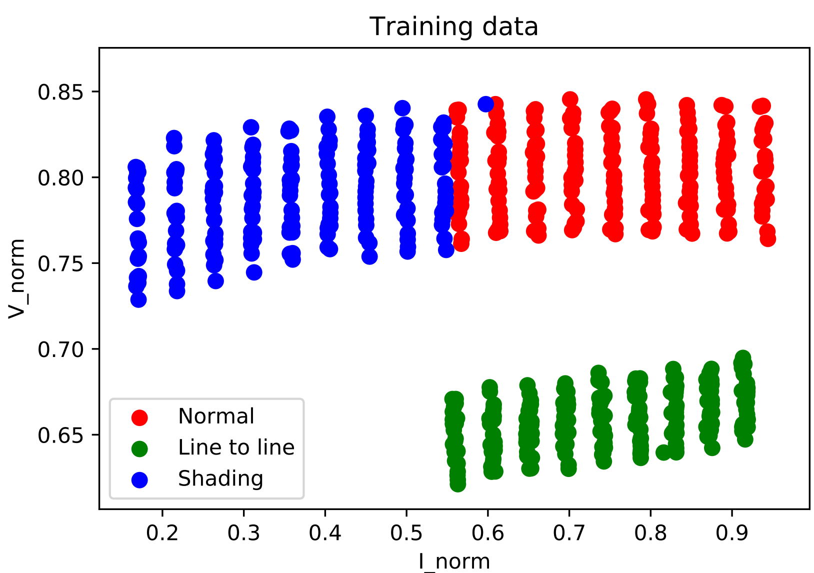

Figure 5: V_{norm} versus I_{norm}.