A Real-Time Simulator Of A Photovoltaic Module

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1. Introduction

In the development and performance test of maximum power point tracker and converter, it is hard to guarantee PV module output due to the solar insolation and temperature [1].

In this poster, a real-time simulator of a PV module is developed with the following functions:

- Calculate the solar position
- Obtain real-time weather conditions through Yahoo! Weather
- Detect and measure the external load
- Generate electric output

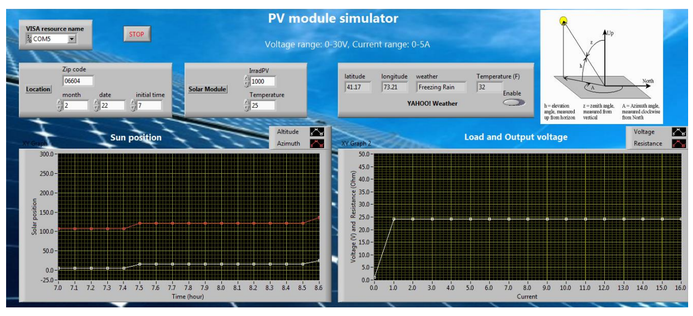


Figure 1 The front panel of the simulator

Figure 1 shows the user-friendly interface and the only input to the simulator is a zip code

2. Simulation Models

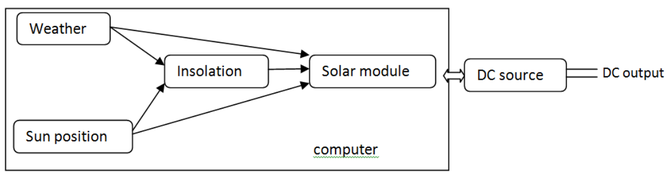


Figure 2 The structure of the simulator

The structure includes four modules shown in Figure 2 and the Solar module is the core which interacts with the other three and the physical instrument, DC power source.

2.1 PV Module

Table 1 Characteristic parameters of the PV module

Irradiance (w/m^2)	V_{oc} (V)	I_{sc} (A)	V_{mp} (V)	I_{mp} (A)
1000	22.1	5.21	17.9	5.03
800	21	4	17.5	3.5
600	20.5	3	17.5	2.5
400	20	2	17.5	1.5
200	19	1	17.5	0.7

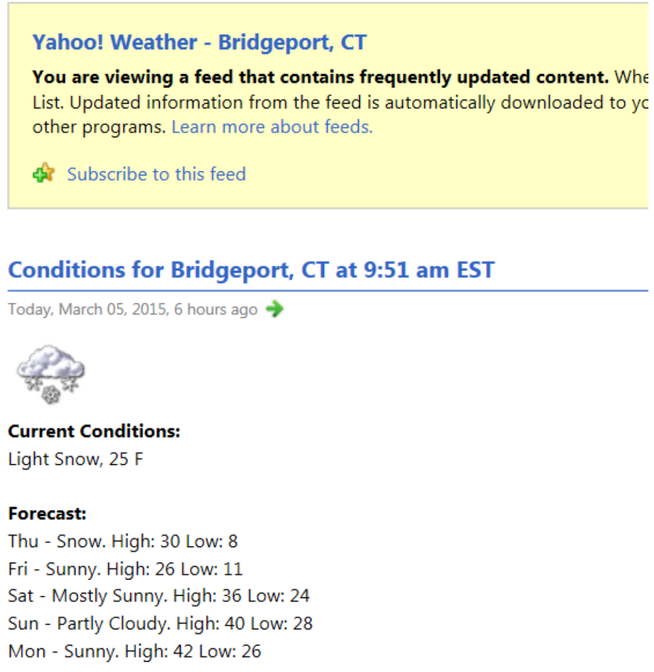
Table 2 Temperature coefficient

	%/°C
Voc	-0.36
Isc	0.105
Vmpp	-0.408
Impp	-0.0281

$$I = I_{sc} - A(e^{BV} - 1)$$

$$V_{OC,ambient} = \alpha\left(T_{STC} - T_{ambient}\right) + V_{OC,rated}$$

2.2 Weather Conditions



The real-time weather condition is obtained through Yahoo! Weather RSS Feed. This is implemented through the LabVIEW HTTP Get function and the xml file parsing.

2.3 Solar Position

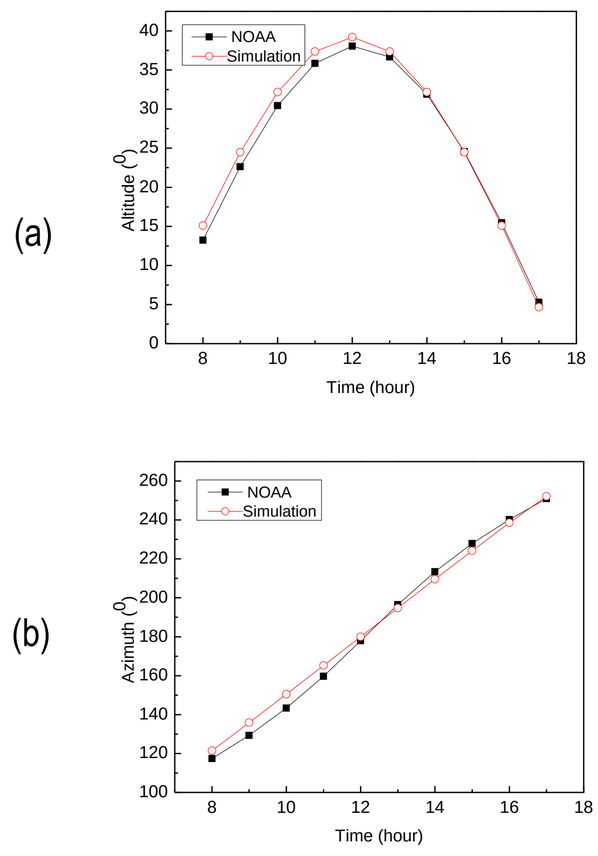


Figure 3 Comparison of the Azimuth (a) and solar altitude (b) between the calculation and the reference [3] on Feb. 20, 2014

3. Experimental Setup

Programmable DC Load
TekPower 3711A
(0-500Ω)

Programmable DC Power Source
BK Precision 1788
(0-32V, 0-6A)

LabVIEW software

4. Results and Discussion

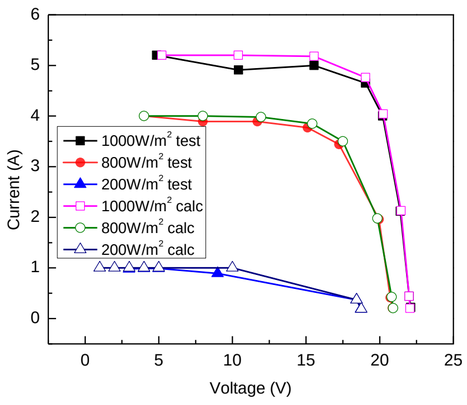


Figure 4 The comparison of the IV curves between the simulator output and the theoretical under different irradiance levels.

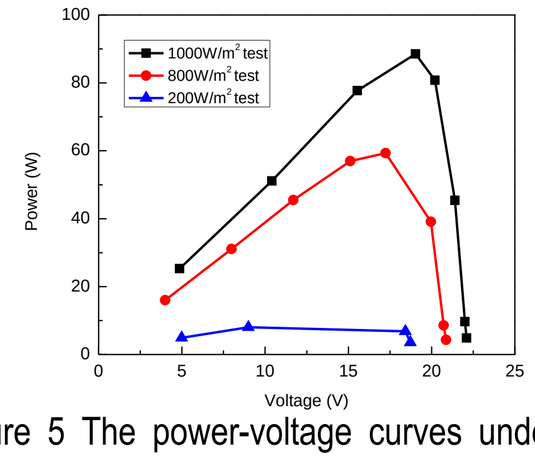


Figure 5 The power-voltage curves under three irradiance levels

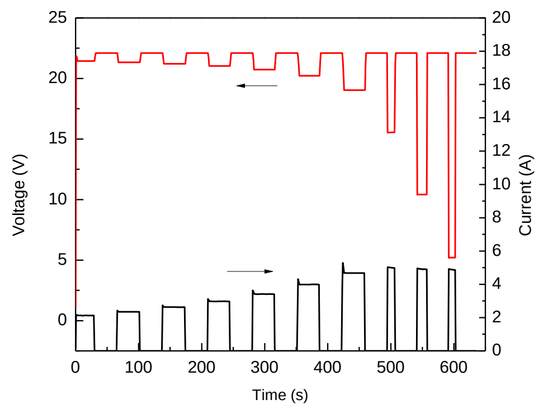


Figure 6 The dynamic output from the simulator

Figure 4 show that the simulator output is very close with the maximum voltage difference 0.4V. Figure 6 shows the fast response of the simulator.

5. Conclusion

The simulator can be used to replace a real PV module for the development of MPPT and converters

References

1. Minwon Park, I.-K.Y., A Novel Real-Time Simulation Technique of Photovoltaic Generation Systems Using RTDS. IEEE Transactions on Energy Conversion, 2004. **19**(1): p. 164-169.
2. Linfeng Zhang, The performance of a grid-tied microgrid with hydrogen storage and a hydrogen fuel cell stack, Energy Conversion and Management, 2014, 87:421-427
3. http://www.esrl.noaa.gov/gmd/grad/solcalc/azel.html