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Comparisonal Analysis Of Incremental Conductance And Perturb And Observe Methods As MPPT Algorithm In Photovoltaic System

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ABSTRACT

Photovoltaic is a semiconductor device that utilizes photon energy from the sun to be converted into electrical energy. The electrical energy produced by photovoltaic is optimized by a system called Maximum Power Point Tracking (MPPT). MPPT will find the optimal working point of the photovoltaic and keep it always working at that point. In this study, the methods used to find the optimal work point are Incremental Conductance and Perturb and Observe. MPPT is connected to the Boost Converter as a photovoltaic voltage controller. The analysis of the two MPPT methods was carried out through simulation in MATLAB/Simulink. The photovoltaic model is designed with reference to the KS80M-36 photovoltaic model. The MPPT system that has been designed is then simulated and its performance is seen. The MPPT system that has been designed using the Incremental Conductance algorithm and the Perturb and Observe algorithm has succeeded in finding the optimal photovoltaic working point and is able to respond to changes in environmental conditions by finding new optimal working points. The two MPPT systems are also able to make photovoltaic work at that optimal point. The Incremental Conductance algorithm has a power ratio of 96%, while the Perturb and Observe algorithm has a power ratio of 95.4%. The MPPT system that has been designed using the Incremental Conductance algorithm and the Perturb and Observe algorithm has succeeded in finding the optimal photovoltaic working point and is able to respond to changes in environmental conditions by finding new optimal working points. The two MPPT systems are also able to make photovoltaic work at that optimal point. The Incremental Conductance algorithm has a power ratio of 96%, while the Perturb and Observe algorithm has a power ratio of 95.4%.

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1. INTRODUCTION

Solar energy is a natural resource that has a huge influence on the development of life on Earth. Its inexhaustible existence is the reason why solar energy is said to be a renewable energy source.

One application of the use of solar energy is photovoltaic, which is a device that converts photon energy into electrical energy. Photovoltaic offers many advantages including, does not require fuel oil, low maintenance costs, and does not produce noise. Photovoltaic has been widely used as a solution to various common problems, such as helping street lighting, electric vehicles, smart houses, etc.

The main problem in the use of photovoltaic is the low electrical energy produced, especially at low radiation conditions and fluctuating temperatures. In various changes in temperature and radiation conditions, there is a point where solar cells will produce the highest energy with maximum efficiency. This point is called MPP (Maximum Power Point). The location of the MPP is unknown, but can be found by calculating or applying a tracking algorithm (Maximum Power Point Tracking) so that the photovoltaic generated power is always at the MPP in various environmental conditions.

Along with the large community demand for electrical energy, various solutions are sought to cover the shortcomings of solar cells. So that many MPPT algorithms have been found and researched, in previous studies research has been carried out using various methods such as Perturb and Observe, Incremental Conductance, Dynamic Approach, Temperature Methods, Artificial Neural Network, Fuzzy Logic Method, etc.

2. RESEARCH METHOD

The research steps are as follows:

a. Data collection
   The data for photovoltaic is taken from the KS80M-36 datasheet. The value of radiation and temperature as input to the photovoltaic is made to vary.
b. Making Photovoltaic Models, MPPT, and Boost converters
   After the data is obtained, then make a photovoltaic model based on the datasheet used, MPPT with Perturb and Observe algorithm, MPPT with Incremental Conductance algorithm, and Boost converter.
c. Running Simulation
   The simulation is run by giving radiation and temperature input to the photovoltaic module. Simulations are carried out on a system designed with the Perturb and Observe algorithm and the Incremental Conductance algorithm. From this simulation we can see the output values of the two systems and compare and analyze them.
d. Showing Results.
   In this study, the authors want to see the performance and differences of a photovoltaic system using MPPT with Perturb and Observe algorithms and Incremental Conductance.

3. RESULTS AND DISCUSSIONS

The photovoltaic system has been built and tested in chapter 3 to have the appropriate characteristics with the reference photovoltaic model. The Incremental Conductance, Perturb and Observe, and Boost Converter algorithms connected to MPPT have also been designed in chapter 3. The next discussion is the analysis and simulation of the system that has been designed and built in chapter 3.

3.1 System Simulation at Fixed Environmental Conditions

Figure 1 shows a simulation block diagram of the MPPT system that has been built. Thus, the MPPT system can be simulated on SIMULINK-MATLAB. In this section, the system will be simulated under standard measurement conditions, namely radiation of 1000W/m2 and photovoltaic temperature of 25℃. Figure 3.6 shows the characteristic curve of photovoltaic when the radiation condition is 1000W/m2 and the temperature is 25℃. Where the maximum power that can be achieved by photovoltaic is 80Watt.

a. Simulation Without MPPT

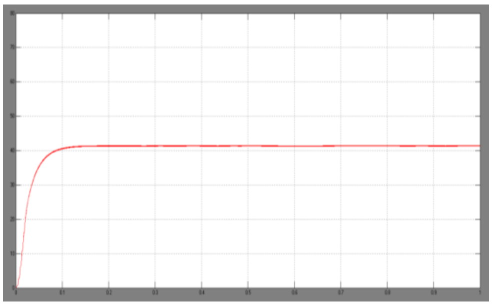

Figure 1. Photovoltaic Power Curve Without Using MPPT

The photovoltaic power curve, in this state the photovoltaic is capable of producing 76.49 Watts of power. This value is the steady state condition of the Ppv(t) curve. When compared with the maximum power that can be produced by photovoltaic in Figure 3.6, which is 80 Watts. It can be seen that the power generated by the system with this algorithm is able to approach the maximum photovoltaic power value. This value is not suitable because Ppv is isolated, so the Ppv data has a spread of the average value. The rounding done in the calculation also makes the imbalance appear. From the figure, it can also be seen that the oscillation occurs when the MPPT system has found its optimal working point.

3.2 System Simulation In Changing Environmental Conditions

In this section, the MPPT system will be simulated under changing environmental conditions. In order to be able to carry out in-depth analysis and see the performance of this algorithm, two different simulations were carried out. In the first simulation, the radiation conditions varied while the temperature was kept constant. In the second simulation, the temperature conditions varied while the radiation was kept constant.

a. Radiation Change

In this simulation, the radiation value will vary, either increasing or decreasing. Table 1 shows the adjustment of changes in light conditions in the simulation to be carried out. The temperature is kept constant at 25℃.

Table 1. Variation of Radiation Conditions

NO	Simulation Time(s)	Radiation (W/m2)
1	0 t < 1	800
2	1 t < 2	500
3	2 t 3	1000

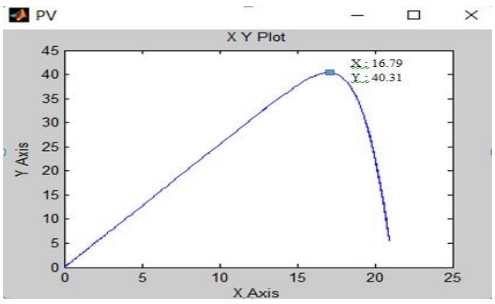

Figure 2. PV Photovoltaic Characteristics Curve At 500 W/m2 . Radiation

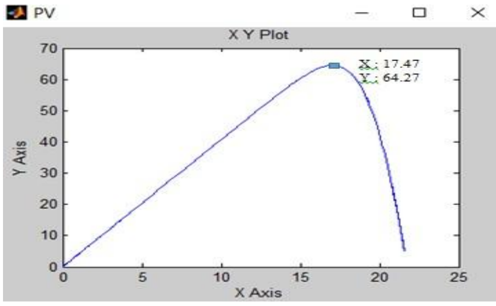

Figure 3. PV Photovoltaic Characteristics Curve At 800 W/m2 . Radiation

Figures 2 and 3 show that at radiation of 500 W/m2 the maximum power that can be achieved by photovoltaic is 40.31 Watt, while at radiation of 800 W/m2 the maximum power that can be achieved by photovoltaic is 64.27 watts. That way, the value that must be achieved by the MPPT is the maximum power, and is constant in that area.

b. Simulation Without MPPT

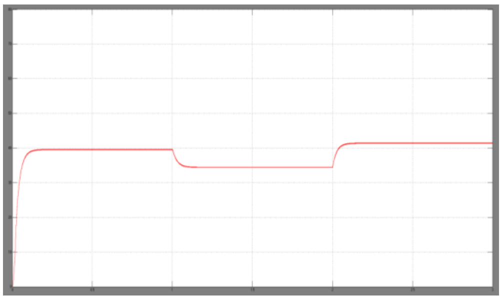

Figure 4. Photovoltaic Power Curve Without MPPT at Varied Radiation

Figure 4 shows that the power generated by photovoltaic without using MPPT under varying radiation conditions. When the radiation is 800 W/m2, the power generated by the photovoltaic is 39.6 Watts. When the radiation drops to 500 W/m2, the power generated is 34.44 Watts. And when the radiation rises to 1000 W/m2 the power increases to 41.53 Watts.

3.3 Incremental Conductance Algorithm

In this experiment, a photovoltaic system that has been connected to the Incremental Conductance algorithm will be simulated with varying radiation conditions and constant temperature. Where will be tested with radiation that varies within 3 seconds.

Under varying radiation conditions, MPPT will track the maximum power that the photovoltaic can produce under those conditions. When the radiation is 800 W/m2, the maximum power generated by the photovoltaic is 61.53 Watts and will be constant in that area. When the radiation drops to 500 W/m2, the power generated is 38.78 Watts. And when the radiation rises to 1000 W/m2, the power also increases to 76.49 Watts.

3.4 Perturb and Observe Algorithm

In this experiment, a photovoltaic system that has been connected to the perturb and observe algorithm will be simulated with varying radiation conditions and constant temperature. Where will be tested with radiation that varies within 3 seconds.

That under varying radiation conditions, MPPT will track the maximum power that can be generated by photovoltaic under these conditions. When the radiation is 800 W/m2, the maximum power generated by the photovoltaic is 61.19 Watts and will be constant in that area. When the radiation drops to 500 W/m2, the power generated is 38.7 Watts. And when the radiation rises to 1000 W/m2, the power also increases to 76.14 Watts.

3.5 Photovoltaic Power Comparison

The following is an image of the power against time generated by photovoltaic using an algorithm and without an algorithm.

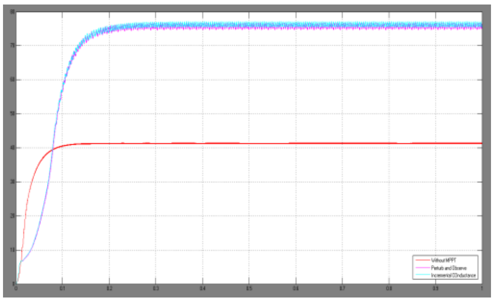

Figure 5. Power Curve Against Time at 1000W/m2 Radiation Conditions with 3 Methods

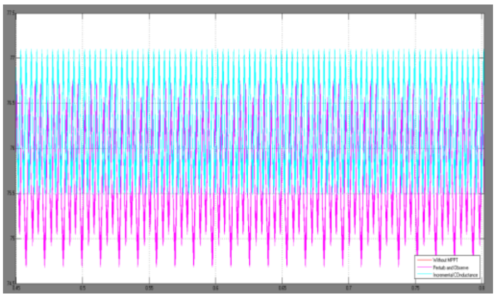

Figure 6. Power Curve Against Time at 1000W/m2 Radiation Conditions with Incremental Conductance and Perturb and Observe Algorithms

From Figures 5 and 6 it can be seen that the power generated by photovoltaic with MPPT using the Incremental Conductance algorithm produces fewer fluctuations than Perturb and Observe. In determining the maximum point the fastest is also obtained by MPPT with the Incremental Conductance algorithm.

After testing the Incremental Conductance and Perturb and Observe algorithms, the data collected is shown in the following table:

Table 2 .Comparison of Photovoltaic Power in Incremental Conductance and Perturb and Observe Algorithms

Radiation	Temperature (°C)	PMPP Theoretical	Without MPPT	P&O (Watt)	Efficiency (%)	InC (Watt)	Efficiency (%)
500	25	40.31	34.44	38,70	96.0	38.78	96.3
	27	39.95	33.98	38.30	95.9	38.42	96.3
600	25	48.51	36.77	46.51	95.9	46.52	95.9
	27	47.95	36.26	45.97	95.9	46.17	96.3
800	25	64.27	39.60	61.19	95.2	61.53	95.7

	27	63.50	39.07	60.59	95.4	60.95	96.0
1000	25	80.00	41.53	76.14	95.2	76.49	95.6
	27	79.50	40.88	74.63	93.9	75,80	95.3

From table 2, the power generated by photovoltaic using both Incremental Conductance and Perturb and Observe algorithms is almost the same, where the difference is approximately 0.5 Watt. So, it can be said that both algorithms are able to find the optimum point of a photovoltaic. Overall, the algorithm that has a higher efficiency is Incremental Conductance. But the simplest algorithm to design is Perturb and Observe.

4. CONCLUSION

At a radiation condition of 1000W/m2 and a temperature of 25℃, the maximum power that can be achieved by the KS80M-36 type photovoltaic is 80 Watt. MPPT with Incremental Conductance algorithm is capable of producing 76.49 Watts of power while MPPT with Perturb and Observe algorithms is 76.14 Watts.

The Incremental Conductance and Perturb and Observe algorithms as MPPT algorithms are proven to be able to find the optimal working point of a photovoltaic in varying radiation and temperature conditions, even MPPT is also able to respond quickly and find new optimal points when radiation conditions change rapidly. When the radiation conditions change from 500W/m2 to 1000W/m2, MPPT with the Incremental Conductance algorithm is able to change the power from 38.78 Watts to 76.49 Watts. While the Perturb and Observe algorithm changes the power from 38.7 Watts to 76.14 Watts.

The MPPT system with the Incremental Conductance algorithm has a power efficiency of 96% while the MPPT system with the Perturb and Observe algorithm has a power efficiency of 95.4%.

REFERENCES

Hegedus, S., & Luque, A. (2003). *Handbook of Photovoltaic Science and Engineering.* West Sussex: John Wiley & Sons.

Tsai, H.-L., Tu, C.-S., & Su, Y.-J. (2008). Development of Generalized Photovoltaic Model Using MATLAB/SIMULINK. WCECS.

Babgei A. F., 2012, Rancang Bangun Maximum Power Point Tracker (MPPT) pada Panel Surya Dengan menggunakan metode Fuzzy, Institut Teknologi Sepuluh November, Surabaya.

Widodo, Rusminto T., Rugianto, Asmuniv, Sejati, Purnomo, "Maximum Power Point Tracker Sel Surya Menggunakan Algoritma Perturb And Observe", Politeknik Elektronika Negeri Surabaya-ITS, Surabaya, Indonesia.

Schmid, J., & Schmidt, H. (2003). Power Conditioning for Photovoltaic Power Systems. In Handbook of Photovoltaic Science and Engineering (pp. 863- 903).John Wiley & Sons, LTD.

Esram, T., & Chapman, P. L. (2007). Comparison of Photovoltaic Array Maximum Power Point Tracking Techniques. Energy Conversion, IEEE Transactions on , 22 (2), 439 – 449.

Hart, D. W. (1997). Introduction to Power Electronics. New Jersey: Prentics-Hall.

Athimulam Kalirasu, Subharensu Sekar Dash, "Simulation of Closed Loop Controlled Boost Converter for Solar Installation", Serbian Journal of Electrical Engineering Vol. 7, No. 1, May 2010, 121-130.

Lin, L. K. (2009). A Hybrid Wind/Solar Energy Converter. SIM University.

Ananduta, Wayan Wicak (2011). Simulasi dan Analisis Sistem Maximum Power Point Tracker Berbasis Rangkaian Boost Converter. UI, Depok, Indonesia.