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Maximum Power Point Tracking of Photovoltaic Systems

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Abstract
An appropriate way to access the maximum power point (MPP) of the PV panel has been tested and studied. The P&O method was used in the current study. The flexibility of this method was studied when solar radiation changes from 300 W/m^2 to 1000 W/m^2, and when the temperature was varied from 10°C to 70°C.
The study's results clarified that the produced output power curves were fluctuating around the maximum point and they stabilized after 0.3 seconds. The climate data for the Baghdad-Iraq station were used in this study for one year (2017-2018). The solar radiation intensity was divided into groups as well as the temperature. The study results manifested that response time when Baghdad data used was between 0.2 to 0.3 seconds.

Keywords: maximum power point, PV, Perturbation and Observation (P & O)

1. Introduction

The strengthening and stability of energy sources is one of the most important concerns of the world countries. Fossil fuels are still the main source of energy. Fossil fuels have been used for two centuries to produce energy, whether for heat, electricity, or running machinery and equipment [1, 2]. Excessive use of diesel and gasoline in motor vehicles and buses is causing significant air pollution if added to millions of tons of pollutants from power plants; the result is disastrous [3]. Climate change has become a reality and a real impact on human life conditions in many parts of the world [4]. If all this is added, the prices of crude oil have been fluctuated for political reasons, which mean the instability of the oil market and thus caused by major economic problems for the producing countries and the countries importing this article [5]. The trend to use renewable energies clean and environmentally friendly has become a reality and many countries have turned to take advantage of the potential and renewable energies available to them [6].
The sun is the cause of all energies on the surface of the earth; it is the cause of all kinds of other energies. It is the first source of heat, which can be used to heat the water for domestic purposes [7, 8], and can be used for heating of salt ponds and heat stored in these ponds [9, 10]. Sun heat is currently used in the Trombe wall [11, 12]. Solar radiation is also used in distillation of water [13, 14]. Solar heat can also be used in power plants, such as a solar chimney or a concentrated solar plant [15-18].
The use of photovoltaic (PV) panels for the production of electric power is the maturity of methods by which the solution of the electricity crisis or reduce dependence on fossil fuels [19, 20]. Photovoltaic panels are currently being used in vast areas around the world. The fuel used by these panels to produce electricity is solar radiation and is always available and free [21]. These systems are used in road lighting [22], lighting cars parking garages [23], and are used to operate communication stations [24], and to operate water pumps in remote areas [25-27]
Photovoltaic systems are vulnerable to external weather conditions, so they are always affected by changes in environmental factors such as the intensity of solar radiation [28], temperature [29], relative humidity [30], and shadow [31, 32]. Any change and fluctuation in these factors will directly affect the maximum energy value that can be produced by the solar

Cell, which is the outcome of the highest effort and the highest current [33]. Many researchers in recent years have studied this problem in many ways and have developed divergent solutions. Many environmental influences still need typical solutions that are not yet specific.

Perhaps the most recent thing that researchers have reached is the use of PVT systems instead of PV systems to produce electricity and thermal energies [34-36].

In these systems, the temperature of the photovoltaic cell is reduced by drawing the heat from it using a heat transfer medium such as air or water [37-40]. Because both mediums have low heat transfer coefficients, it is proposed to add high thermal conductivity nanoparticles to form nanofluid used in cell cooling [41, 42]. These systems have also been updated with the addition of heat storage. The most recent of these systems is what the researchers have done by adding nanotubes to the thickness to increase the thermal conductivity of the material in addition to the use of nanowire for cooling and access to the efficiency of kidney limits of 96% [43-44].

Any slight change in weather conditions directly affects the PV cell system. This effect is evident from the I-V and P-V curves [45]. Radiation and temperature can be considered the most important direct-impact air variables mentioned above. MMPT represents one point on the P-V curve and is the maximum capacity generated by the solar cell [46, 47].

There are currently many methods to reach the maximum point of energy in photovoltaic cells and these methods are different from each other such as direct and indirect way, connected to the Internet and non-connected to Internet. Some of these methods are complicated by accuracy. These methods depend on variables such as speed and scalability, and it is important to pay attention to cost versus tracking efficiency [48, 49]. Solar radiation changes from moment to moment and from one day to the next, according to the seasons of the year. The existence of a mechanism that controls the system and follows the change in solar radiation and controls the direction of the solar cell to meet the requirements of electric load can be considered important issue for increasing the PV module efficiency [50, 51].

Volatile and non-static load resistance has a significant impact on photovoltaic output power. Therefore, achieving the load resistance of the PV module with maximum power enables optimal processing value, where Vop and Iop are at their optimum values [52, 53]. Load resistance values correspond to the change in solar radiation and temperature, which means the change in the intensity of solar radiation or the temperature changes the characteristic curves causing a transition to a new location. The correlation between solar radiation intensity, load change, and temperature is achieved by changing the transformer cycle [54, 55].

There is only one point for each photoelectric panel called MPP located on the voltage-current (I-V) curve. At this point, the PV system works at maximum efficiency with maximum output power. Although this point is important, MPP is only known when using MPP algorithms. The hatch point must be traced to the practical point of the PV array. Access to a MPP point is done by using direct and indirect methods. Known methods use photovoltaic or current voltage or both and classify these as methods as direct methods. In this way, there is no need to know in advance about the characteristics of a plank plate and here the muff does not depend on the temperature [56-59].

The indirect method is that the prior knowledge of the photoelectric properties is important for creating the mathematical relationship that will be formed using empirical data. Example of Indirect Methods, Research Table, Curve Installation, Open Circuits and Short Photovoltaic Voltage [60-62]. The most common methods for tracking the maximum energy point are the installation of the curve (CF), open circuit voltage (OCV), short circuit current (SCC), fuzzy logic control (FLC), interference and control (P & O) [63].

The P & O method is a common method of exploiting for MPP point. In this way, the photovoltaic cell output power is sensed and compared with the previous state. Here, the voltage is changed according to the change of load and the observation and tracking of the MPP. Working at MPP increases the voltage and the power produced and reduces the disturbance.

The Perturbation and Observation (P & O) tracking method was selected to be used in this study. The solar radiation and temperature measured from the Baghdad City Station for 2017-2018 were taken as input parameters. During this study, each variable will be compared with the time response to obtain the optimal MMP model for the city of Baghdad, Iraq.

2. Research Methodology

The MPP point is located at the intersection of the voltage-current curve. This point represents the maximum point of energy produced [64]. A method of MPP tracking is usually used to obtain the best match between voltage and current generated with the load required by simple dc-dc converters using the MPPT algorithm. Perturbation and Observation (P & O) is a simple method in which there is no need for prior knowledge of the properties of PV panels [51]. This method works so that when the load is increased, the algorithm adjusts until the difference between the solar radiation and the temperature on the one hand and the load on the cell stops on the other. This method is based on the rise and fall of the energy and voltage curve under MPP [64]. The periodic calculation and comparison of the energy produced from the PV panel is used to change and modify the resulting capacity for MPP tracking [61]. The P & O algorithm is easy to apply and depends on the incremental step of the voltage change and the breadth and magnitude of this calculation step. When the intensity of solar radiation is increased, the voltage is changed from one value to another, which causes a change in the produced power that results in an increase in energy [66]. One of the main influences on PV cell productivity is the temperature. Therefore, the change in temperature and the resulting differences must be observed and responded to in the P & O method. Studies have shown that the effect of temperature on oscillation in solar cell productivity is less than that of solar radiation. That the increase in temperature will cause a decrease in the capacity produced due to the low voltages generated by the electromagnetic panel while the current is stable.

3. Results and Discussions

3.1 Model with Irradiance Conditions

Fig. 1 shows the effect of solar radiation variation on the produced power and response time. The solar radiation intensity for Baghdad city station varied through the studied period between 260 W/m^2 up to 870 W/m^2. The results indicate that at the low solar radiation intensity, the generated power was low while at higher intensity higher power was produced (Positive relation) in P & O method. The curves manifest that it reached stability after 0.2 to 0.3 seconds.

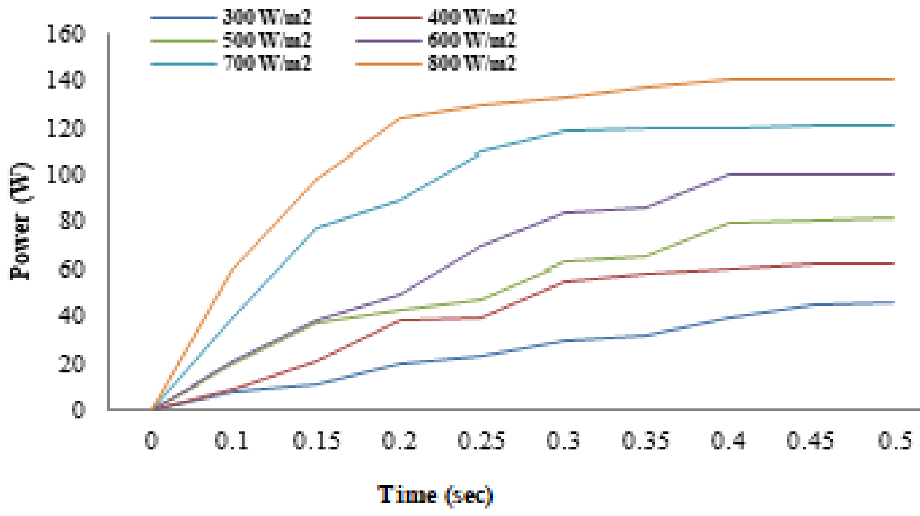

Fig.1: Perturb and observation method with irradiance range

Fig. 2 represents the impact of the PV panel temperature variation on the produced power and the response time. The temperatures range for Baghdad station varied from 10°C to 70°C.

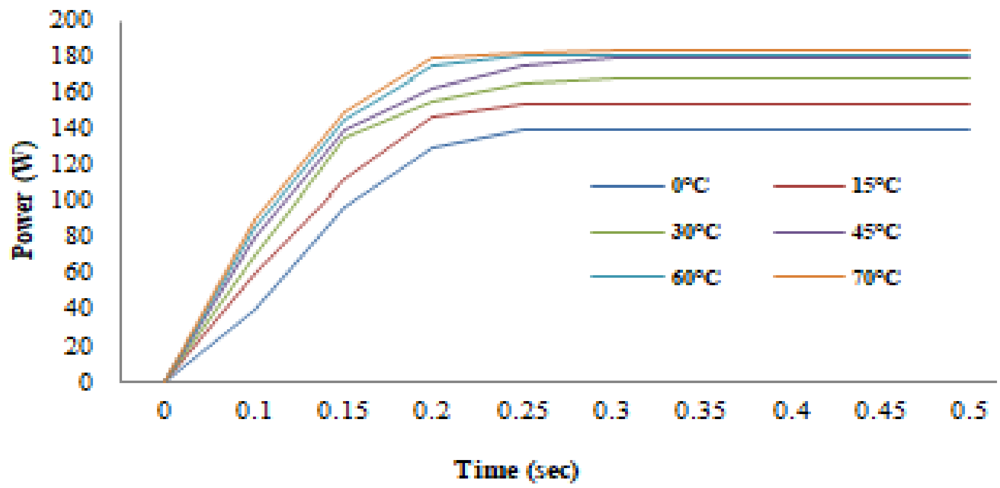

Fig. 2: the perturb and observation model in the temperature

When P&O model was used, the power achieved at 70°C was up to 140 watts. At 50°C, the power of the used PV cell reached 155 watts. At temperature of 25°C the resulted power 170 watts. All the time when the P&O method was used the resulted power was increased with temperature reduction. At temperature of 10°C the generated power was up to 178 watts.

Conclusion

In the current study, the use of the P&O method to reach the maximum power produced of a photovoltaic panel installed in Baghdad was processed and tested. The observed weather conditions were taken from Baghdad City Station for the year 2017-2018 and the response time was tested using the above method when the radiation and temperature changed. The results showed that the solar radiation of the city of Baghdad ranges from 260 to 860 W/m^2 and temperatures ranging from 10 to 70°C. The tested the method used by dividing the solar radiation into groups ranging from 300 W/m^2 to 900 W/m^2. The same was used when studying the temperature as it was divided into groups. The results showed that the use of this method allowed maximum output power and response time of 0.2-0.3 sec. The output power curve fluctuated around the maximum power point and the curve began to stabilize after 0.3 seconds.

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