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Design and Implementation of Maximum Power Point Tracker for Solar Powered Vehicles

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ABSTRACT

The purpose of this article is to design and implement maximum power point tracker which has simple structure and high efficiency for the Eskişehir Technical University Solar Car Team. In order to see the results in advance, the designs were first tried in simulation programs. In solar-powered systems, curve of power has parabolic structure so the system must be kept constant at a certain voltage value to obtain maximum power. Devices that hold the system at this maximum power point are called the Maximum Power Point Tracker (Mppt). There are different algorithms to find the maximum power. In this project, Perturb and Observe Algorithm has been used. The working principle of this algorithm is to calculate the output power of the panel and change it by increasing or decreasing the voltage and recalculate the output power after each change. If the output power increases, the change is repeated in the same direction, otherwise the change direction is reversed. According to the result of this algorithm, the processor produces a signal with a specific duty cycle. The generated signal comes to the switching element of the Buck-Boost Converter. Buck-Boost converters are a type of DC-DC converter that can increase or decrease the output voltage, and these converters change the voltage according to the signal with the specific duty cycle sent by the processor. Thus, the system reaches the required voltage value for maximum power.

Keywords: Maximum Power Point Tracker, Efficiency in Solar Systems, MPPT, P&O Algorithm, Buck-Boost Converter

Introduction

The energy need of the world increases with the developing technology. Humanity has increased fossil fuel consumption to meet this need. Since fossil fuels are harmful to the environment and can end in thirty years, people have sought alternative energy sources. Therefore, investments in renewable energy sources such as wind energy, thermal energy, solar energy have increased, and these investments have revealed that solar energy has more potential than the sum of all other energy sources. In addition, the fact that other renewable energy sources cannot be used in vehicles also means that the importance of solar vehicles will increase in the coming years. Research in this area has also shown us that the biggest problem of renewable energy sources is energy storage and efficiency. With the developing battery technology, the biggest problem we faced was efficiency.

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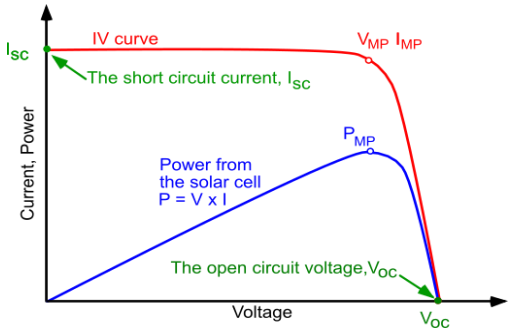

Figure 1 P-V and I-V Curve of solar panels

In solar systems, efficiency is achieved by finding the maximum power. The power that can be obtained in these systems has a parabolic structure. Therefore, the system should be kept at a certain voltage value.

Methodology

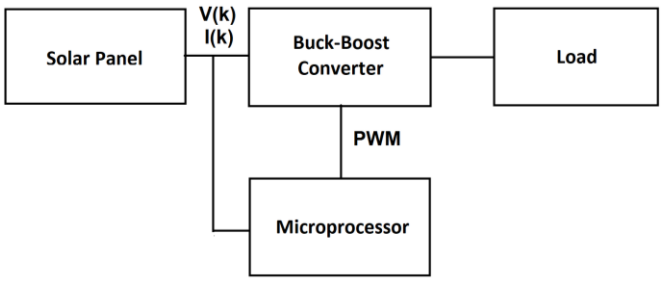

Figure 2 Mppt block diagram

Maximum power point trackers aim to give maximum power to the load by balancing current and voltage from the panels. Different algorithms are available to find the maximum power. Perturb and Observe Algorithm is used in this project. According to the result of this algorithm, the processor generates a specific signal in the duty cycle. The generated signal changes the voltage supplied to the output of the Buck-Boost Converter. Thus, the system reaches the required voltage for maximum power. In order to realize our project via simulation, it is necessary to transfer all equipment or equivalent circuits to the simulation program. We used the LAB center's Proteus in this project. We transferred each piece seen in the block diagram to the simulation.

Solar Panel

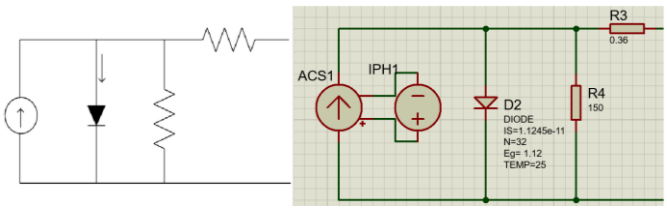

Figure 3 Solar panel equivalent circuit and its equivalents in simulation

Solar panels are electronic equipment that converts the light coming from the sun into electrical energy. In order to use it in simulation, the equivalent circuit of the solar panel must be transferred to the simulation. We created the equivalent circuit in our simulation program by using the values of our panel. The panel simulation we created gave similar results to the panel we have.

Buck-Boost Converter

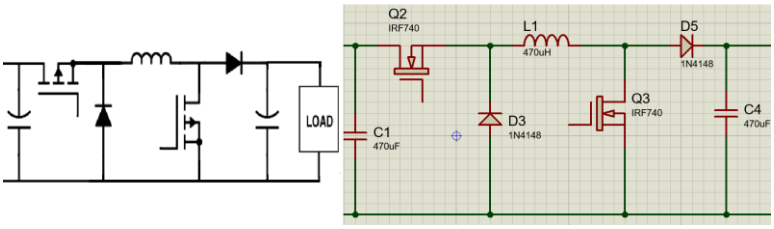

Figure 4 Two switch Buck-Boost Converter and its equivalents in simulation

Converters that can increase or decrease the output voltage are called Buck-Boost Converters. They are converters that increase the voltage at the output if the duty cycle of the signal coming to the switching equipment exceeds 50% and decrease it if it drops below 50%. In this study, the Buck-Boost Converter was used to change the output voltage and find the maximum power.

Perturb And Observe Algorithm

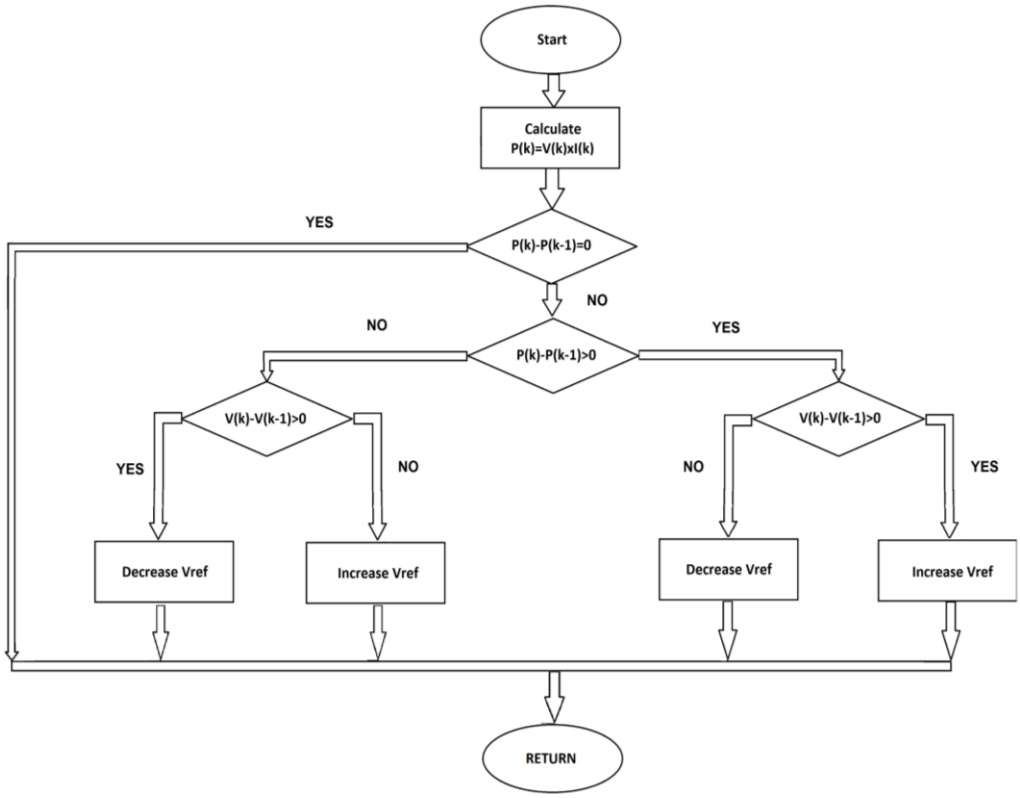

Figure 5 Perturb and Observe Algorithm

Perturb & Observe Algorithm is one of the most frequently used algorithms. This algorithm works independently of environmental conditions. The basic principle of this algorithm is to calculate the output power of the panel and change it by increasing or decreasing the voltage. Output power is recalculated after each change. If the output power increases, the change is repeated in the same direction, otherwise the change direction is reversed. This change continues until the maximum power point is found.

Results and Discussion

Table 1. Powers at different loads

Load	Power without Mppt	Power with Mppt	Efficiency%
20 Ohm	22,89 Watt	37,05 Watt	161,86
25 Ohm	18,49 Watt	40,66 Watt	219,90
30 Ohm	15,55 Watt	38,50 Watt	247,58
35 Ohm	13,45 Watt	36,75 Watt	273,23

As can be seen in the table, the efficiency obtained increases when the load value is increased. The efficiency achieved here is found by changing the ideal working load of the panel. Because the ideal working load of the panel we designed without Mppt is 17 ohms. By connecting Mppt to the system, we moved it to approximately 50 ohms. In this way, we were able to increase the power obtained at increasing load values at the same panel values. By customizing the design for each vehicle, the ideal value between the panel and the motor of the vehicle can be found and maximizes the power obtained.

Conclusion

As a result, we learned that Mppt increases the energy obtained from the panels and can be designed using various algorithms. Since our project was carried out via simulation, we transferred our panel in simulation environment. We found that Buck-Boost Converter is suitable for the converter used in the project. We design a Buck Boost Converter in simulation program. Also, we tried the Perturb and Observe Algorithm and completed our simulation. According to the results, we observed that the power obtained at increasing load values increased and the ideal load value changed. In this way, we learned that the energy from the panels can be used more efficiently in different loads.

Acknowledgments

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