Control Strategy of Photovoltaic Power system based on message-driven

Shudong Wang¹, Ting Ding¹ and Jinliang Qiu¹

¹College of Electrical and Information Engineering, Lanzhou University of Technology, Lanzhou, Gansu, 730050, China

e-mail: 1377574460@qq.com

Abstract. In this paper, a method of using battery as the complementary method of energy storage in photovoltaic power generation system is put forward to cut the peak and fill the valley of the output power of photovoltaic power generation, so as to improve the stability of power system and the integrality of power consumption, and thus stabilize the output power quality. The system can achieve the effect of complementary energy. Considering the change of light intensity, the charging and discharging mode of battery is changed by setting voltage threshold based on message driven strategy. The simulation results show that this method can stabilize the voltage, reduce the charge and discharge times of the battery, realize the complementary energy, and prolong the service life of the battery.

1. Introduction
Solar photovoltaic power generation, also known as photovoltaic cells[1]. When photovoltaic cells work near the maximum power point, solar energy can be converted to electricity as far as possible. In this paper, based on the complementation of photovoltaic generation and battery, message driven system is applied to photovoltaic power generation system. The message is generated by detecting the degree of fluctuation of the busbar voltage which is in the transmission line, and then the charging and discharging order is issued to the battery. The system can achieve the purpose of ensuring the power quality of photovoltaic power generation systems and energy complementation. At the same time, it relieves the charge and discharge pressure of the battery and prolongs its service life[2].

2. Energy complementary control strategy
"Message" is a basic and important concept in the operation mechanism of computer system, is a notification of the occurrence about an event. Message driven is developed around the generation and processing of messages, and relied on the message loop mechanism to achieve. A message may be regarded as the occurrence of an event. The structure of the entire PV system constructed according to the message-driven control strategy is shown in Figure 1 below. The message driving device determines the type of event occurrence based on the measured voltage signal, thereby determining the operating state of the battery.
We use DC-DC as a boost chopper circuit to achieve MPPT [8]. The output voltage of photovoltaic cell can be adjusted by changing the turn-on rate of power switch to realize maximum power tracking [3-5]. The boost chopper circuit is shown in figure 2.

The $U_0$ is the average value of the output voltage and the $E$ is the input voltage. The relationship between them is as follows:

$$U_0 = \frac{t_{\text{on}} + t_{\text{off}}}{t_{\text{off}}} E = \frac{T}{t_{\text{off}}} E$$  \hspace{1cm} (1)

The $T/t_{\text{off}}$ is a boost ratio, its reciprocal is $\beta$. And the duty cycle is $\alpha=\text{ton}/T$. Which has the following relationship: $\alpha + \beta = 1$. Thus the (1) can be expressed as

$$U_0 = \frac{1}{\beta} E = \frac{1}{1-\alpha} E$$  \hspace{1cm} (2)

Then the output voltage of the power supply can be changed by adjusting the value of duty cycle $\alpha$ from formula (2).

The output power of photovoltaic power generation is greatly changed by environmental factors such as solar radiation intensity and temperature. The disturbance observation method is adopted for MPPT to ensure that the photovoltaic system can work at the maximum power output state, so that it can make the maximum use of solar energy [6-7]. A voltage increase or decrease is given to the PV array every fixed time. Then we can observe whether the output power is increasing or not, and then decide whether the next step is to increase the voltage or decrease the voltage. Figure 3 is a flowchart of disturbance observation method.
Based on the model of photovoltaic energy storage in this paper, the control strategy based on message driven mechanism is designed. The constants $\alpha_{\text{max}}$ and $\alpha_{\text{min}}$ are set, where $\alpha_{\text{max}}>1$ and $\alpha_{\text{min}}<1$. At the same time, $V(t)$ is the voltage of the system at time $t$. And $V^*(t)=V(t)/V_n$ is the voltage standard value, the $V_n$ is the reference value of the system voltage. When the system voltage is too high, that is, when $V^*(t)>\alpha_{\text{max}}$, the battery is charged, so that the battery is charged to absorb excess energy. When the system voltage is normal, $\alpha_{\text{min}}<V^*(t)<\alpha_{\text{max}}$, the battery stops working. When the system voltage is too low, that is, when $V^*(t)<\alpha_{\text{min}}$, the battery discharge supplements the energy of the photovoltaic system.

3. System simulation results
Considering that the output power of photovoltaic power generation is greatly affected by environmental factors such as solar radiation intensity and temperature, the change is severe. In this paper, the ambient temperature is set at 25°C, and the light intensity is the main influencing factor, and only the change of light intensity is considered. The selected lithium battery has a capacity of 50A.h and a nominal voltage of 35V.

Figure 4. Change chart of illumination intensity
Figure 5 is a comparative diagram of voltage waveform simulation. The voltage of photovoltaic system changes synchronously with the change of light intensity. It can be seen that the system effectively slows down the amplitude of voltage fluctuations after adding the battery. Make it more stable than without battery.
Figure 5. Voltage variation contrast diagram.

Figure 6 shows the working state of the battery, 1 is the charging state, -1 is the discharging state, and 0 is the stopping state. It can be seen from these figures, the change of illumination intensity can bring the fluctuation of system voltage. At the same time, the working state of battery also changes with it. When the voltage is too high, the state is 1, it is in a state of charge, and absorbs the excess energy of the system. When the voltage is too low, the state is -1, it is in the state of discharge, and provides energy for the system. When the voltage of the system is normal, the state is 0 and the battery stops working.

Figure 6. Working state diagram of battery.

4. Conclusion
By using the message driven strategy designed in this paper, the battery working state has been controlled, and the power quality has been improved to a certain extent. At the same time, the working time of battery can be shortened effectively and the service life of battery has been prolonged. Based on this, renewable energy sources with instability can be exploited more fully.

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