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Design of Photovoltaic Centralized Management System for Storage Batteries Based on Internet of Things

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***Abstract*—In order to solve the problem of short life of lead-acid batteries under abnormal operation and maintenance, a centralized photovoltaic management system of lead-acid batteries based on Internet of Things was designed. The system uses photovoltaic cells as energy devices, adopts embedded technology to realize battery status monitoring and control, and realizes batch charging management of batteries remotely through Internet of Things technology. The experimental data prove that the design prolongs the service life of the battery and improves the working efficiency, which has certain economic significance.**

Keywords—internet of things; cloud server; battery; photovoltaic; centralized management

I. INTRODUCTION

With the development of network technology, the application of Internet of Things is gradually diversified. Entertainment, life, national defense, transportation, it can be said that the Internet of Things has affected people's lives. With the increasing degree of automation, centralized management also improves the efficiency of work.

II. DESIGN BACKGROUND

In the application of photovoltaic energy, batteries will be used as energy storage medium to provide energy for the equipment when there is not enough light. Lead-acid batteries are mainly used at present because of their low price, mature technology and strong applicability. Its working principle is that the positive and negative electrodes of batteries react chemically under the action of electrolyte to produce free electrons, thus providing energy. It belongs to one kind of chemical batteries. The chemical expressions are as follows:

$$\text{Charging: } 2PbSO_4+2H_2O = PbO_2+Pb+2H_2SO_4 \quad (1)$$

$$\text{Discharge: } PbO_2+Pb+2H_2SO_4=2PbSO_4+2H_2O^{[1-4]} \quad (2)$$

It can be observed that the charging and discharging process of lead-acid batteries is a process of mutual conversion of lead sulfate, water and lead oxide, lead and sulfuric acid. Among them, lead sulfate is insoluble in water and has poor conductivity. If the battery is discharged deeply and not replenished in time, the so-called "electricity deficit" will lead to the accumulation of lead sulfate, which is not conducive to the full charge reaction, that is, the so-called "sulfurization" phenomenon, reducing the storage capacity of the battery.

During the charging process, the water molecules in the electrolyte will inevitably be electrolyzed to produce hydrogen and oxygen. Higher charging voltage will aggravate the occurrence of electrolysis reaction. The generation of large amount of gas will cause the chemical substances of the plate to fall off and reduce the service life of the battery. On the premise that the voltage is set as high as possible, it is determined by the ambient temperature and cannot be unchanged.[5-9]

At present, the main solution is manual patrol, charging the battery found in the monitoring process, and adjusting the battery charging voltage combined with environmental temperature. However, this scheme is not very effective in some specific situations, such as the scattered distribution of equipment is not conducive to inspection one by one, or the remote location of equipment is not conducive to manual site inspection.

In order to solve the above problems, combined with the analysis of battery damage mechanism, this paper studies a new method and means of battery use, maintenance and management. Form a centralized management design of battery photovoltaic based on the Internet of Things. It can use the Internet of Things technology to achieve centralized management to improve work efficiency, and can use embedded technology to achieve battery condition monitoring and state control to improve battery life.

III. TECHNICAL PROPOSAL

The main method of this design is to install a maintenance controller based on embedded system design between solar photovoltaic panels and batteries, which can automatically monitor and control the charging process. At the same time, the battery status can be uploaded to the cloud server Elastic Compute Service (ECS) through the wireless data transmission module through AP instruction and received by remote monitoring equipment. At the same time, the remote monitoring device can also send control instructions to the maintenance controller through the cloud server to control the battery charging and discharging status. As shown in Figure 1.

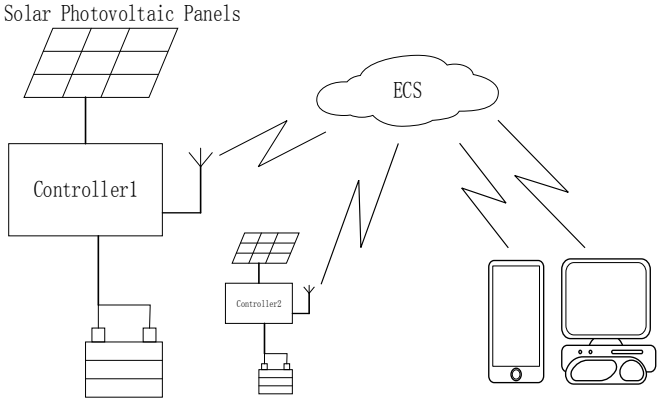

FIGURE I. FUNCTIONAL SCHEMATIC

The main function modules of the maintenance controller in this design are shown in Figure 2.

The circuit module of the main control chip uses embedded controller as the core, completes the state acquisition of the battery through its internal pre-programmed program, and automatically realizes the functions of charging voltage adjustment and charge-discharge control of the battery according to the state of the battery. The circuit module of the main control chip can also realize data transmission between the data communication circuit module and the remote centralized management equipment, and realize the function of status reporting and remote control. At the same time, the circuit module of the main control chip can conveniently access the data after storage.

The flow chart of the program is shown in Figure 3.

The state acquisition circuit module realizes the adjustment of battery voltage, temperature, charging current and other parameters. DC-DC Voltage Conversion Circuit Module realizes the voltage generated by solar photovoltaic panels controlled by the main chip circuit module to achieve stable output. [10] The data communication circuit module is controlled by the main control chip circuit module, which realizes data transmission with remote centralized management equipment. The power module provides the energy needed for the maintenance controller.

In addition, ECS is a simple, efficient, safe, reliable and flexible computing service. Its management is simpler and more efficient than physical servers. At present, ECS is very mature in the field of commercialization.

Centralized management equipment can centralize information, so that staff can understand the status of equipment without going to the scene. Greatly improve the efficiency of maintenance and management personnel.

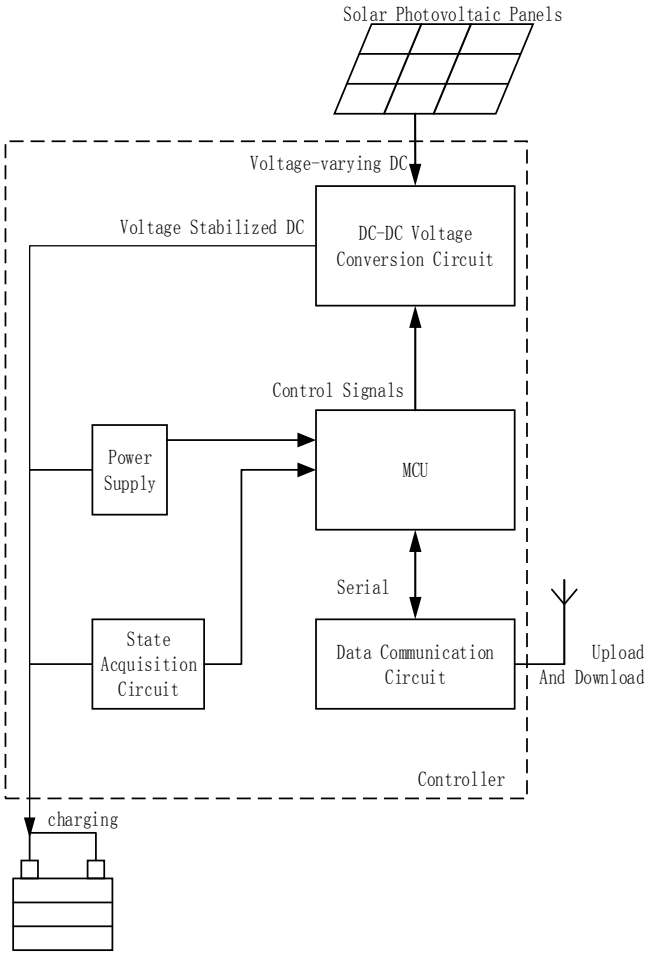

FIGURE II. SCHEMATIC DIAGRAM OF FUNCTIONAL MODULES

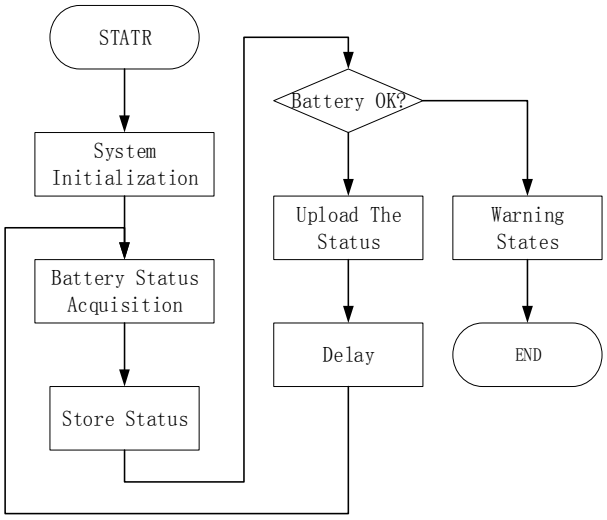

FIGURE III. THE FLOW CHART OF THE PROGRAM

IV. EXPERIMENT

The same batch batteries were used to test the same equipment. Half of them adopt the centralized management

design, and half adopt the traditional charging control technology to compare. After half a year of operation, the performance of the battery designed by this method is better than that of the battery using traditional charging control technology. At the same time, in the process of battery condition monitoring, the task of using the designed battery is obviously easier than using the traditional charging control technology. The experimental data are shown in the table 1.

TABLE I. TABLE HEADINGS

	Average Collection Time of Battery State	Average life time of battery	Rate of equipment in good condition.
Experimental Group	5 min	83%	96%
Control Group	1 h	68%	98%

V. RESULT

In this paper, the design of centralized management of battery photovoltaic based on the Internet of Things, combined with the Internet of Things technology to optimize the application of photovoltaic energy, achieved centralized management of battery for electrical equipment. The service life of storage battery is prolonged and the resources are fully utilized. At the same time, the working efficiency is improved and the labor force is saved. It has a certain significance of application and promotion.

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