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The Key Technology of Ocean Wave Power Generation

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Abstract: *A new type of wave power generator, called combined buoy wave power generation plant. Technicist use its Mechanical movement to reverse wave power to electric power. Here we only discuss the power control system of the whole device. With the help of main controller, we can send the real time data through DTU to computer, like voltage, current, power etc. We can observe them from particular software. Then use Offline memory module, to store the off-line data. Compared with wave period and height data, we can get the ability of the whole device's generation efficiency.*

Keywords: *ocean wave power generation; power control system; real-time data; generation efficiency;*

1. INTRODUCTION

Ocean wave energy is a pollution-free, clean, new and renewable energy and has a unique advantage. Its technology is developing rapidly. There already have engineering prototype. In recent years, lots of countries have invested a lot to study the technology of ocean wave generation device, [1~3] like Britain, USA, Norway, Australia, and Ireland. [4]Shore-based wave energy generation technology has developed slowly. But Off-shore generator, modular technology has developed into main direction. At present new device and new technology have come out in a large number. Research including theoretical study and small-scale offshore engineering prototype test in the ocean. This paper mainly bases on the program named <The key technologies for ocean buoy data observing system >. But the key technology is how to control the energy conversion, here we only discuss electric control system, mostly bases on DTU communication and controller control the conversion of electrical and digital signal. Go through theoretical analysis and experimental research to verify the actual, both illustrate the feasibility of the circuit device. In first period of experiment, we can get the whole system's design, including theoretical analysis of control system and power supply system respectively. Then evaluate the circuit's adaptability and ability and give analysis conclusions. Last but not least, after the whole test in the ocean, we get the data, then get the conclusion of circuit control system's reliability.

2. WHOLE CIRCUIT DESIGN

The electric system is the core of whole floating device, on one hand it controls the conversion of mechanical power to electric power. On the other hand, it controls transmission of data. So it is indispensable to the wave buoy generation device.

The design principle of electric system. Use two main controller to take charge of the whole system, including motor generate and data transmission through DTU. Two controllers control two motors' generation, efficiency and voltage separately. This design not only can realize the control of DTU's charging and data transmission, also can realize the reverse charging from motor to battery. It can achieve energy recycling, on one hand, can realize the battery providing power to controller, on the other hand motor can charge for battery through controller. In that way, can maintain the device works for a long time. The circuit of whole control system is shown in fig.1.

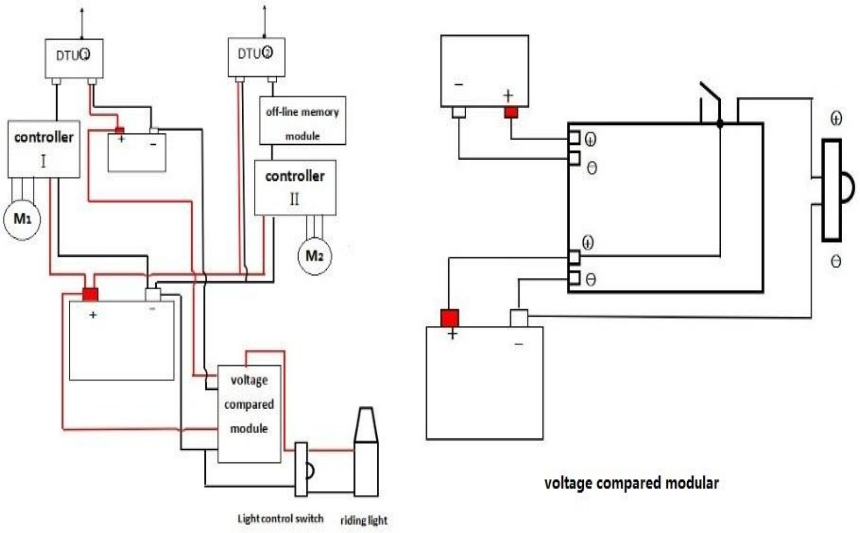

Fig1. *Whole electric system and voltage compared module inner structure*

In the figure above, we use voltage compared module to ensure not make battery over charge to damage. We put this module to system so that can prevent battery over charge using a riding light to power consumption at night.

3. WORKING PRINCIPLE

The main idea of electric system is: with two controller control motor generation and battery power consumption and charge by the float moving up and down, driving the movement of rack and pinion, then rotate the motor to work. On one hand, the controller controls the conversion of electrical and mechanical. On the other hand, it controls receiving signals of DTU. The controller can provide the real time data of motor's generated electrical energy, generated voltage, generated current and battery's voltage, current etc. Then use DTU to send these data to upper computer. With the help of monitoring software, we can monitor the real time data anytime. With the help of monitor software, it provide us the information of real-time data of battery's voltage current and power, and motor's real time voltage and current. Finally, the whole generated electrical energy will be shown to us. Every day's generation, every month and the whole generation would be recorded. This system could update time automatically.

4. BASIC COMMUNICATION THEORY

The whole communication system is made of monitoring center, GPRS net and site GPRS control loop.

- Monitoring center: The center can monitor and write all the message of outside device, it is a operate platform for operator to control the whole electric system. Almost every monitoring work is finished in PC.
- GPRS data transfer internet: The GPRS net is the gallery for data transformation, the controller of GPRS can realize the communication with monitoring center through the GPRS Internet. After negotiation with telecom operator and with a slice of payment. We can realize the goal of transfer data.
- GPRS control loop: The GPRS control circuit accept downlink control command, transfer uplink state information, and carry out the control command, every long distance control loop is communicate with monitoring center by a GPRS controller. As is shown in fig.2.

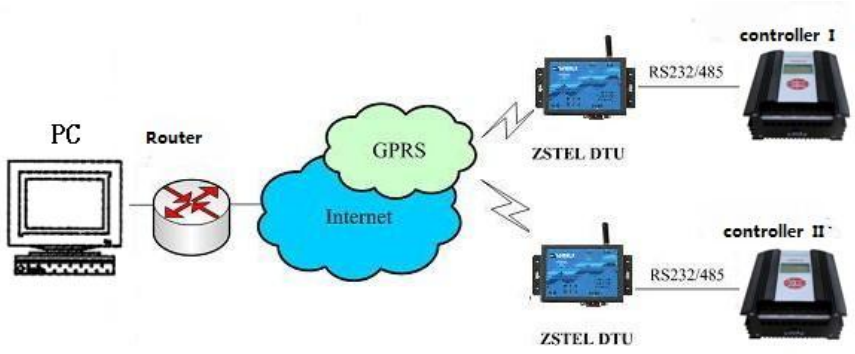

Fig2. *Communication loop*

DTU communication protocol follows with TCP/IP protocol and sends back the data to upper computer through the Internet. With the help of particular software, we can set the port for data transfer, and set the inter value of two DTUs through RS232 port.

5. Introduction of Main Part in Circuit

5.1. Main Controller

Controller's performance is crucial, it affects lifetime and operation stability of the entire system. Especially to the battery's lifetime. It has features below:

- Reliability, Intelligent, modular design, simple structure, powerful function.
- SD card storage function: under the circumstance of no communication, use SD card to store historical data.

5.2. DTU

DTU (data transfer unit), is the wireless device mainly used on change serial port data to IP data or reverse and transport through Internet. It has following characteristic:

- Provide bidirectional serial data conversion function, DTU provides serial communication interface, including RS232, RS485 etc. And GPRS DTU can convert original data on serial port into TCP/IP packets for transmission, without changing the original data communication content.
- Support automatic heartbeat package, with it can maintain a permanent online. Support automatically reconnect when connection is broken, and automatic redial.

5.3. Voltage Compared Module

Its function is protect the battery is over-charged, with the help of light control switch and riding light, we can consume the power of battery at night.

The module needs to be charged, then compare the compared voltage with threshold one. In this test, we set our threshold voltage to 12v, if battery is overcharged, we can realize charging the battery in the daytime, and charging with consumption at same time at night. Its work principle is shown below:

In the fig3, point 1 and 2 are for the supplied power input;

3, 4 are for compared power input;

5 for relay status indicator; when 6, 7 is connected, the indicator is on, disconnected the indicator is off.

10, Adjustable resistance, Adjust the reference voltage value. We can get the basic voltage from point 9.

When compared voltage is bigger than threshold voltage, foot 7 and foot 6 of relay will connected. The indicator light 5 will turn on. The modular is accessed. The light-controlled switch and riding light is charged, at night the riding light begin to consume the power of battery.

We put this modular for battery over-charged, has great significance for protecting battery.

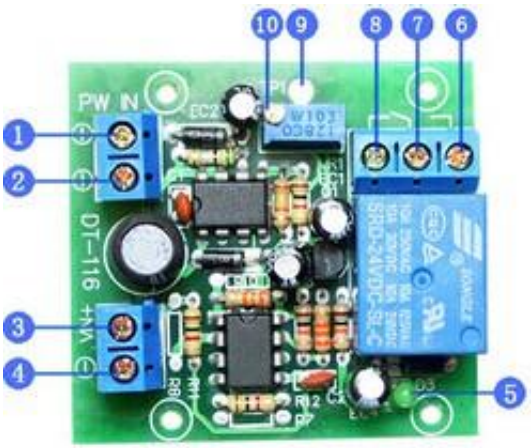

Fig3.*Voltage compare modular*

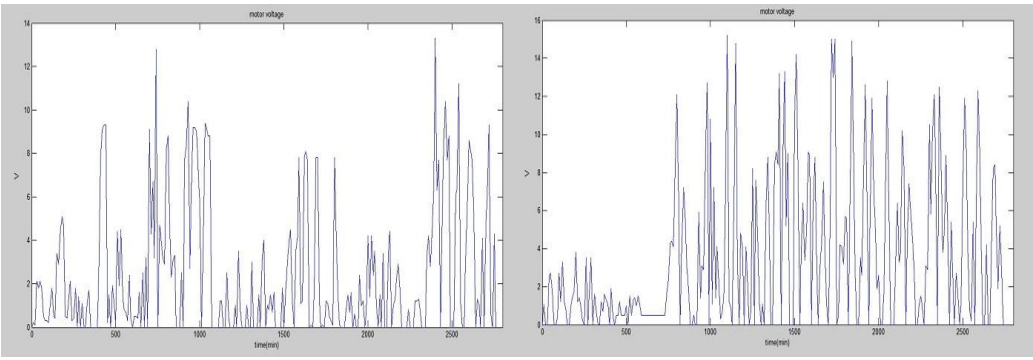

Fig4. *Motor voltage change when device go up and down*

5.4. Whole System Performance

All electric device should be located in the equipment at seaside.

The capsule must keep desiccation. And the transportation and assembling process should be without big shock and vibration. After this, we can begin our whole equipment test.

6. RESULT AND DISCUSSION

On one hand, data collection can realize from monitoring software. But the system cannot store the real time data. On the other hand, data can store in electric system Offline storage module. But the storage data has time interval. The offline storage modular has a build-in 8G storage card. When whole equipment is draw back from ocean, we get the storage card, we can extract the data with corresponding software. The equipment has been test in the ocean for days, we can analyze the data of battery voltage, current and motor voltage, current, power etc.

Monitor software collect real-time data, get one group pre- -second, even though the data can't be restored, still can reflect motor generation situation, and tidal wave condition. The motor voltage is higher, means that wave condition is better. The monitor software can monitoring two controller at the same time. Even two controller are both charged by big battery, but monitored battery voltage are different. The difference is no more than one voltage.

After the test, the whole equipment was draw back from ocean, we get out the SD card of offline storage modular. As for special reason, our device was hit by a freighter and destroyed, so the ocean test time is short. The effective working time is 2760 minutes. Every ten minutes, get a group data recorded, add up to 276 groups of data, each group including two controller's data. So totally 552 groups of data. In such short days of testing, the equipment totally generate 26WH electricity. With the help of MATLAB, after data processing, we get two controller's voltage, current and power. Controller one take charge of the power generation when the whole device go up; controller two take charge the power conduction when it goes down. The figure 4 below are the electric conduction of controller one and two.

Then with the reference of ocean wave height and period, we get the sum of two motors' max power. Shown in fig.5.

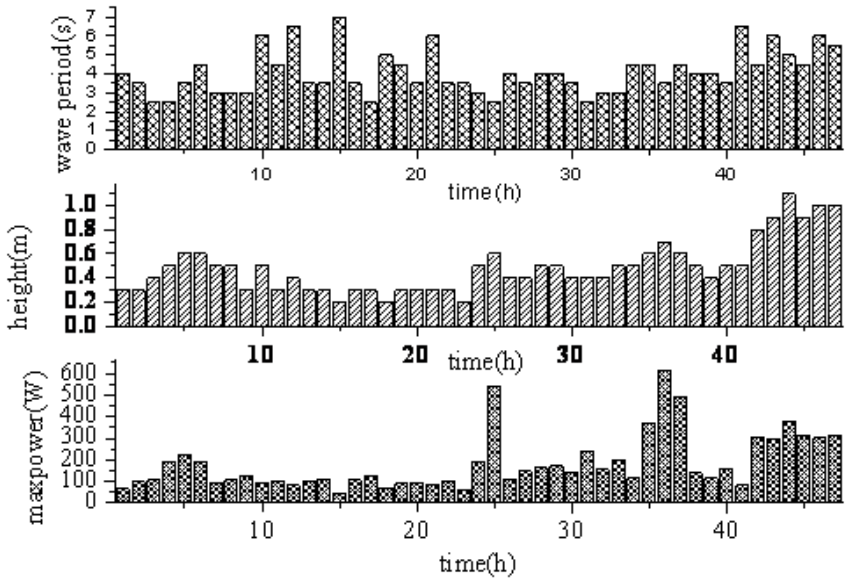

Fig5. *Max power of two motors compared with wave height and period*

From the figures 4, the two motors' electric generation almost even, but with the time changing, the changing rate of generation is different. As motor power generation is related to its rotation speed. As the device floating up and down is related to wave height and period. And the time of tide rising and ebb is not fixed, so the wave's height and period are random. From the data above, the voltage of motor is higher, means that the wave condition is better. The max power occurs at the time when period is 3.5s and height is 0.7m.

7. CONCLUSIONS

The electric system is mainly about coordinate with the floating device. It controls energy conversion and data transfer. From the data above, electric system's generation ability is changeable by the wave height. The whole electric system not only can achieve real-time monitoring, but also because of the off-line memory module, in the non-monitoring period data can also be monitored and recorded. From the ocean test of whole device, its adaptability in complicated and arduous ocean test condition can achieve the desired goals.

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