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The Design of Buoy System

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Abstract: The Argo project is a global ocean observation experiment project launched in 1998. In the past 20 years, more than 30 coastal countries worked together to distribute nearly 10,000 Argo buoys across the world's oceans and formed a global ocean monitoring network. For the first time, real - time observations of the temperature, salinity and depth of the world's oceans in real terms. It has played a vital role in people's life and work. Western developed countries have developed deep-sea buoys with depths below 4,000 meters, while China's technology is still in its infancy. The deep-sea Argo buoys can observe the ocean parameters of the deep sea, so that they can better study the ocean to serve human activities and facilitate people's life and work. It can also increase China's influence in the world to some extent[1]. This paper designs a preliminary control system for deep-sea Argo buoy. A control system for Argo buoy is designed and applied to 4000 meters deep sea.
Keywords: Deep-sea Argo buoy; Msp430. Data collection; Control system.

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1. INTRODUCTION

Since the beginning of the 20th century, with the continuous development of the world economy, the demand for resources has continued to increase in various countries, land resources have decreased, and countries have turned their attention to the vast oceans. With the gradual increase in the exploitation of the oceans, especially deep-sea resources, the competition for marine resources among countries has gradually increased. Therefore, the monitoring of the marine environment as a technical support for the development of the ocean plays an increasingly important role. Moreover, China has a vast area of marine resources. The coastline of the mainland is as long as 18,000 kilometers, the continental shelf area is nearly 1.1 million square kilometers, and the total jurisdiction of the sea area is about 3 million square kilometers. In some sea areas, due to the lack of deep-water observation buoys adapted to severe sea conditions, the monitoring of this part of the sea area is relatively small. A complete monitoring network is not yet available, and it is difficult to grasp the long-term, continuous, and accurate statistical data on the state of the ocean. Therefore, for China, developing a new

type of buoy suitable for various depths of sea (especially deep water and ultra-deep water) and establishing a corresponding monitoring network for marine environment buoys are very necessary.

Marine buoys, a new type of marine monitoring tool, have been developed on the basis of traditional marine monitoring technology. It is a kind of unattended monitoring system, which can automatically, fixed point, timing and continuously telemetry various environmental factors at sea. It forms a three-dimensional ocean monitoring system with maritime surveillance aircraft, satellites, marine survey ships and submersibles. Self-sinking profile probing buoy is an ocean observation platform. It was first applied to the international Argo project. So it is also called Argo buoy. It is dedicated to subsurface ocean temperature, salt, and deep section measurement.

Control system is a management system with its own goals and functions, which consists of the control subject, the control object and the control media. For the design of the control system is completed, the overall design is completed more than half. A system's high reliability, low power consumption, long-time performance, etc., must also be considered in the control system design process. The design of the Argo buoy control system is the core of the buoy design, and is even more important.

2. THE CHOICE OF BUOY STRUCTURE

At present, the deep-sea Argo buoys mainly have two kinds of mature buoy structure types. The first type is shown in Figure 2.1. The main structure is a long cylindrical shape, such as a DEEP NINJA buoy. The technical indicators of the buoy: length 1850mm, weight 75kg; the compressive structure is aluminum alloy and local titanium alloy; the buoyancy is driven by a single plunger pump; rated working pressure 350bar; mechanical efficiency is 40%; the range of buoyancy variation is 2L; depth range can reach 0-4000 meters; no air-sac; The advantages of the buoy are: typical Argo form of expansion, relatively mature technology; low cost of pump system; Less imported parts, and controllable cycle. Disadvantages: difficulty in deep development; the bulk buoyancy ratio is low and the carrying capacity is limited.

As shown in figure 2.2, the buoy type is round glass sphere, such as DEEP SOLO buoy. The technical indexes of the buoy are: 13Inch (about 330.2mm) spherical shell and weight 25kg; The pressure-resistant structure is 13Inch spherical shell; The buoyancy drive is a miniature plunger pump with rated working pressure of 600bar. The fluctuation of buoyancy is 0-6000 meters deep; there are air-sac. The advantages of the buoy are: large volume buoyancy ratio, which is conducive to functional expansion; Simplified housing design; the buoyancy system facilitates deep expansion. Disadvantages: high cost, more imported parts, the cycle is easy to be affected.

In terms of structural design, the minimum depth required for the project is 4,000 meters. To meet the acceptance criteria, cylindrical structure can be used, but the long-term expansion will be limited to a depth of 6,000 meters. The round glass ball shape is adopted in the comprehensive design.[2]

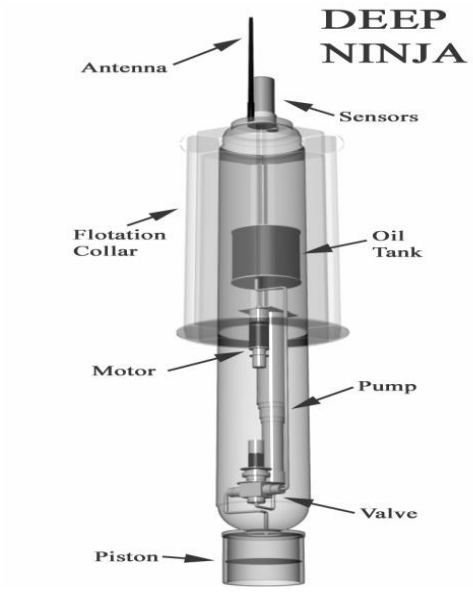

Figure 2.1 DEEP NINJA buoy

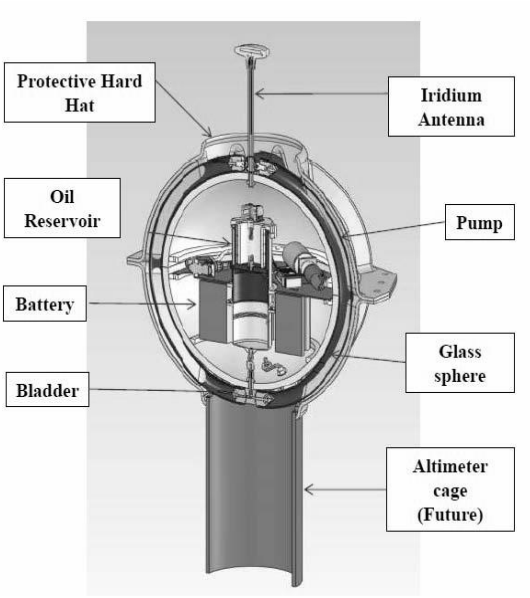

figure 2.2 DEEP SOLO buoy

3. Overall system design

3.1 The choice of wireless communication equipment.

Wireless communications technologies include: Bluetooth, UWB, Wi-Fi, GPRS, IrDA, ZigBee, ect. In this study, ZigBee technology was selected as the control object of wireless transmission, and iridium satellite was selected as the wireless transmission system after launching.

ZigBee

The ZigBee protocol is from bottom to top: PHY, MAC, TL, NWK, APL. The PHY and MAC control layer follow the IEEE 802.15.4(Low-rate wireless personal area network physical layer and media intervention control protocol) standard [3]. The main features are as follows: (1) Low power consumption; (2) Low cost; (3) Low speed; (4) Short delay; (5) High capacity; (6) High security; (7) Unlicensed band.

Iridium 9602

The maximum mobile transmission information of Iridium 9602 is 340 bytes, and the maximum mobile reception information is 270 bytes. Conform to the US, EU and Canada radio transmission, electromagnetic adaptability, AC safety standards. And its main features are: small size, flexible application function, GPS module antenna. Single-type collector interface: connect power supply, switch control, logic level asynchronous Uart control, network, XXMC interface, connect small all-directional l-band antenna, simple AT command interface. Operating temperature: - 40℃ ~ 85℃. Operating relative humidity < 75% RH. Frequency: 1616 ~ 1626.5 MHz. Average current of SBD message sending: 190 mA, average power of SBD message sending: 1.0 W [4]. Based on the above characteristics, iridium communication module is the most widely used communication module. However, the cost of iridium 9602 communication module is high, up to 0.3 yuan per 30 bytes. The test is not easy to use, and

iridium is subject to significant restrictions in the United States. Therefore, ZigBee wireless transmission technology was selected in the initial test stage.

3.2 Selection of sensors

According to the existing deep-sea profile buoy sensor types, CTD type sensors are usually selected, temperature, conductivity and depth were measured. Temperature, salt and depth sensor(CTD): It is used to measure the conductivity, temperature and depth of physical parameters of water. Based on these three parameters, various other physical parameters can also be calculated, such as the speed of sound. It is a necessary equipment for the investigation of oceans and other bodies of water.

3.3 Altimeter

Altimeter is a high precision instrument for various measuring ranges designed for many industrial applications and testing institutions. An altimeter is installed on the buoy to measure the distance between the buoy and the sea floor in a timely manner and to prevent the buoy from hitting rocks and other dangers.

Valeport VA500 submarine altimeter provides a new solution for underwater location measurement. The 500kHZ-sensor enables the current signal processing module to provide excellent measurement range and precision. It can achieve millimeter accuracy, the ROV, AUV and watercourse measurement are integrated, compact structure, solid shell. So it can be used here.

3.4 Motor

If you want the pump to complete the specific oil pumping work, you need the motor drive. The control motor of oil pump selects the DC-gear motor, and the control motor of air pump selects the servo motor.

3.5 The chip of control system

The MSP430 is an ultra-low-consumption microcontroller produced by TI company in Germany. MSP430F5529LP development board was selected based on the principle of low power consumption and high reliability[5].

3.6 Power

The battery of the buoy's power system uses a lithium battery pack. ER34615 (3.6v, 19AH) is selected for the battery pack, with a total of 56 batteries and a total energy of about 14.7MJ (7 and 8 strings of 28.8vdc 152AH).

4. CONCLUSION

With the advancement of ocean research, ocean exploration and ocean development, the deployment of ocean buoys will develop towards a thematic direction to meet the needs of marine topics. Such topics as Marine hydrology, Marine meteorology, Marine biology, Marine chemistry, Marine physics, Marine engineering, Marine geology, Marine environment, etc. To promote the rapid development of Marine science and better serve the national economy and people's lives [6].

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