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Design of Joint Marine Monitoring and Early Warning System

Yongquan Zhao [2,3], Jiahui Zhu [2,3], Jiangjie Shen [1,2,3, a, *], Liang Zhang [2,3], Shengjun Ji [2,3], Jiaan Cao [2,3]

[1]College of Marine Resources and Environment, Hebei Normal University of Science and Technology, Qinhuangdao Hebei 066600, China;

[2]Hebei Technology Innovation Center of Photovoltaic Module Manufacturing Equipment, Qinhuangdao Hebei 066000, China;

[3]Hebei Engineering Research Center of PV Module Encapsulating and Measuring Equipment, Qinhuangdao Hebei 066600, China.

[a]xnshilei@126.com

Abstract

In view of the high cost and difficulty of ocean monitoring, a set of in-situ monitoring buoy and UAV-borne multispectral-hyperspectral combined monitoring and early warning system is designed. The system integrates chemical oxygen demand (COD), chlorophyll, turbidity, temperature and other multi-parameter monitoring sensors, and designs solar in-situ monitoring buoy hyperspectral imaging technology with sensors. The purpose of this system design is to build a three-dimensional marine environmental monitoring system that integrates marine water quality monitoring and air marine ecological inspection. Each monitoring carrier is equipped with a positioning module and a data communication module, which can realize the requirements of real-time monitoring and rapid warning to monitor the pollution of marine waters, prevent accidents and protect the marine ecological environment.

Keywords

Ocean warning, Stereoscopic monitoring, Rapid reaction.

1. Introduction

The ocean is rich in resources, China' s coastline is as long as18000km, there are 12 provinces (cities, autonomous regions) in the coastal zone, 50 % of the country ' s large cities, 40 % of small and medium-sized cities in this area, 60 % of the total value of the national economy from coastal areas[1]. However, in recent years, there have been varying degrees of pollution in offshore waters, with more than 200 pollution inlets along the Bohai Sea and the South China Sea alone. There are more than 50,000 rivers with an area of more than 100 km2 in the river basin, more than 1,500 rivers with an area of more than 1 km2, and more than 2,300 lakes with an area of more than 1 km2, with a total area of 7187 km2. 75 % of these lakes have different degrees of eutrophication, and 90 % of the urban waters have serious pollution [2]. Water pollution often causes heavy losses in aquaculture and tourism. The establishment of remote marine environment autonomous observation system can obtain marine information in real time, reduce the pollution and diffusion of the marine environment, and avoid the loss and waste of related industries due to water pollution, which has great social benefits. The report of the 18th National Congress of the Communist Party of China clearly stated that China should ' improve the ability to develop marine resources, develop marine economy, protect the ecological environment, resolutely safeguard national marine rights and interests, and build a maritime power. In chairing the eighth collective study of the Political Bureau of the Central

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Committee of the Communist Party of China on the study of building a maritime power, General Secretary Xi Jinping pointed out that building a maritime power is of great significance for promoting sustained and healthy economic development and safeguarding national sovereignty, security and development interests. With the increasing emphasis on marine environmental protection, from the national level to all levels of government departments are about to introduce or plan to introduce relevant policies to further support the development of marine monitoring / observation equipment. On this basis, the domestic research on marine monitoring system [3] has also developed greatly. Chen [4] carried out the research on marine disaster prevention and mitigation information platform system based on big data, constructed multi-source and multi-temporal monitoring data such as shore-based and satellite, and constructed the centralized extraction system of marine environmental monitoring information. Dong et al. [5] introduced the design and implementation of a continuous monitoring system for marine environment, which greatly improved the service life of the system. The collaborative innovation and industrialization project of marine multi-parameter in-situ monitoring sensor and system integration fully conforms to the current national and industry policies to vigorously promote the development of marine high-end equipment industry, and is also an important part of industry development. The construction of marine environmental monitoring platform improves the assimilation and application ability of marine environmental data.

China's current marine environmental data mainly come from laboratory tests after artificial sampling, sampling interval is too long, lack of time continuity and real-time. Therefore, it is an important and urgent task in the current marine monitoring field to develop a remote marine environment observation system driven by ocean energy and solar energy, which has the ability of communication, positioning and autonomous navigation control, and can realize the measurement of multiple environmental parameters such as turbidity, chlorophyll, COD and sea surface temperature in large-scale and long-distance seawater, and can transmit data online in real time.

2. System implementation

2.1. System principle

The system is mainly composed of buoys responsible for fixed-point data acquisition and UAVs responsible for large-scale data acquisition. The buoy has the advantages of continuous monitoring and acquisition, but it is limited to fixed monitoring sites. Unmanned aerial vehicle (UAV) can monitor a wide range of areas, and it cannot cruise for a long time because of its high power consumption. In order to meet the needs of rapid warning, it is necessary to combine the advantages of both. The specific working principle is shown in Figure 1:

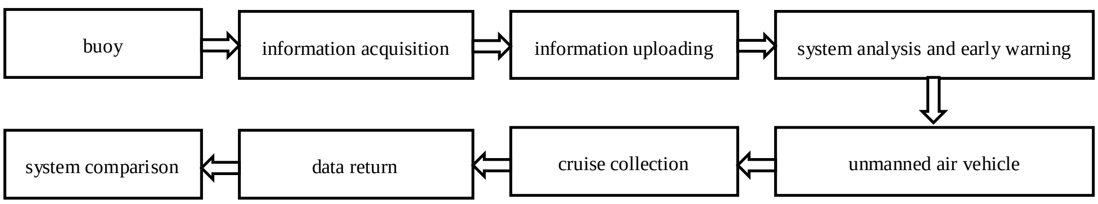

Fig.1 Flow chart of early warning function realization

The fixed-point launched buoy radiates the fixed sea area, forming the marine buoy monitoring network, which is responsible for continuous and real-time monitoring of water quality in the sea area and transmitting the data back. The returned data are analyzed and compared by the marine water quality monitoring network. When the system finds that the water quality parameters of a certain sea area fluctuate, it will issue early warning and issue cruise instructions to the UAV. Unmanned aerial vehicle (UAV) equipped with hyperspectral imager and multispectral camera flies to the early warning sea area. The spectral camera can receive the optical information reflected by the same target on different spectral bands through the combination of various filters or splitters and various photosensitive films, and then the spectral images of several substances in water can be obtained. Through hyperspectral camera imaging and multispectral camera shooting, the spectral image of the sea area is obtained and transmitted back to the system. The water quality of the sea area can be obtained by analyzing the UAV return spectrum image. The integrated monitoring of buoy water quality warning and UAV spectral aerial photography can quickly determine the water quality situation, strive for time for subsequent treatment of water quality problems, reduce the scope of water pollution and the harm to the polluted sea area. Information flow as shown in Figure 2:

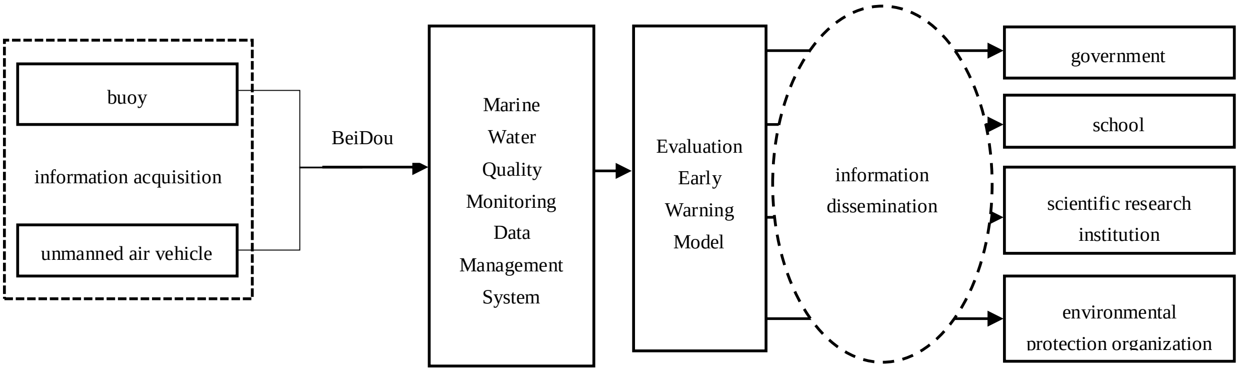

Fig.2 System information flow chart

2.2. Integration of monitoring buoys

As the core part of the joint early warning system, the ocean monitoring buoy network is responsible for the normalization monitoring and real-time information transmission of the fixed sea area. At the same time, buoy early warning is also the first step of monitoring and early warning system, so the integrated design of buoy and sensor is particularly important. To adapt to a variety of sensors and instruments on board, the main parts of the buoy must be adapted to design. It mainly involves the power supply module, communication module and buoy body, and ultimately enables the integrated monitoring buoy to meet the power supply, stability and information transmission required for monitoring. The design flow chart is as follows:

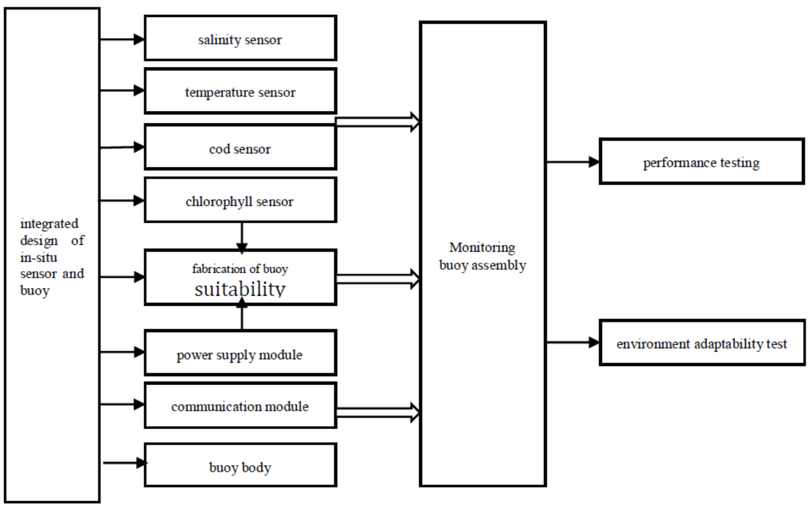

Fig.3 Integrated Design Structure of Sensor and Buoy

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2.3. Weather resistance treatment of sensors

As the core component of ocean monitoring, sensors are expensive. The corrosion of electronic components in the marine environment is various, including seawater corrosion, chlorine corrosion, ultraviolet aging corrosion, biological corrosion, etc. In order to protect the main components such as sensors, extend the overall service life of the buoy and reduce the project cost, it is necessary for the weather resistance treatment of sensors. In order to solve the problem that the circuit part of the sensor is vulnerable to corrosion in the marine environment for a long time, an atomic layer deposition (ALD) technology is used to directly produce a layer of thin film with extremely low water vapor permeability (WVTR) on well-made circuit board. Due to the unique self-limiting growth characteristics of ALD, a layer of thin film with accurate and controllable thickness, dense pinhole-free and ultra-high shape-keeping can be covered on any shape of the substrate. This layer of thin film has very excellent barrier performance, and the same weather resistance treatment is carried out on the contact position between the measured water sample and the sensor.

3. Design of main parts of the system

3.1. Multi-parameter in-situ monitoring sensor

Marine monitoring optical in-situ sensor system consists of oil pollution, temperature, depth, COD and other modules. The online monitoring system consists of a variety of water quality sensors, signal processing subsystem and positioning and communication subsystem. The sensor intends to use the dual-channel multi-source spectral combination technology to reduce the environmental impact of the optical path of the optical in-situ sensor, and use the parameter difference method to correct the errors of water quality in different water areas, so as to improve the universality and stability. MEMS is used for the integrated design of the sensor, the combination of nanotechnology and two-dimensional materials is used for anti-fouling and anti-corrosion of the sensor, and the brush cleaning function is used to realize the self-cleaning of the light window of the seawater quality measurement sensor and ensure the authenticity of the collected data. The sensor design accuracy is shown in table 1:

Table 1 Sensor design accuracy

parameter	measuring range	accuracy	resolution
chllorophyll-a	0-100 ug/L	±0.1 ug/L	0.1ug/L
turbidity	0-100NTU	±0.1NTU	0.1NTU
depth	0-50m	±0.1 m	0.1m
temperature	0-50℃	±0.5℃	0.5℃

3.2. Ocean monitoring buoy

Based on the offshore buoy, a variety of monitoring sensors and supporting equipment are equipped to realize real-time online monitoring of marine water quality, nutrients and other parameters. It can also be transmitted through the traditional GPS positioning and GPRS / CDMA public network to ensure the safety and efficiency of marine monitoring data transmission. The developed comprehensive and multifunctional automatic monitoring platform for marine buoys can eventually realize the accumulation of massive basic data, real-time monitoring of the marine environment, and sharing of marine monitoring data, providing data support and technical support for marine environmental protection, marine comprehensive management, marine disaster prevention and mitigation, and marine public services. Buoy system platform: buoy monitoring station and system management and application service platform. Buoy monitoring station: buoy body, online monitoring instruments, data acquisition and transmission system, power supply system, mooring system, protection system.

3.3. UAV telemetry system

It is composed of UAV platform, load system and control processing software. The hardware part is composed of fixed-wing UAV, stable platform, hyperspectral imager, real-time multispectral camera, GPS (navigation and positioning system) and IMU (attitude measurement system). Hyperspectral imagers and multispectral cameras are arranged in separate front and rear view, and are rigidly connected with IMU to perform fine hyperspectral and real-time multispectral imaging for polluted sea areas. GPS receiver antenna is located above the UAV for UAV tracking and positioning. The fast extraction technology of hyperspectral data based on load dual-carrier design has a large amount of data, and can extract and analyze effective targets quickly and accurately from massive spectral data.

4. Conclusion

With the progress of science and technology and the requirements of the industry, the development and utilization of the ocean will be more important, and the continuous and real-time needs of marine monitoring are also increasing. The construction of a three-dimensional marine environmental monitoring system integrating sea surface water quality monitoring and aerial marine ecological inspection is the key means to meet the above needs. Each monitoring carrier of the three-dimensional ocean joint monitoring and early warning system is equipped with positioning module and data communication module, which can realize the requirements of real-time monitoring and rapid warning to monitor the pollution of marine waters, prevent and prevent accidents, and protect the marine ecological environment.

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