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Control System of Intelligent Monitoring and Warning Equipment for Marine Heavy Metal Pollution in Port

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Abstract

In order to improve the monitoring performance of the intelligent sea metal pollution in the port, the control system of the intelligent monitoring and warning equipment for the heavy metal pollution in the port is designed. This paper presents an intelligent monitoring and warning equipment control system for sea metal pollution in port based on DSP. The dual 16-bit fixed-point DSP is used as the intelligent information processing chip for the intelligent monitoring of heavy metal pollution in the port, and the real-time sampling of the heavy metal pollution in the port is carried out. The pollution of heavy metal pollutants in port seawater was detected by both visual analysis and chemical analysis. The hardware module of the system is mainly divided into the port seawater heavy metal pollution material sensing information collection module, the pollution substance detection pattern recognition module, the remote terminal communication transmission control module and the man-machine interaction module and so on. The program control module of MUX101 is designed to alarm and control the heavy metal pollution of sea water in port intelligently, and the software development and design of the control system of pollution monitoring and warning equipment is carried out under the embedded kernel. Finally, the experimental results show that the system can be used to monitor the pollution of sea water intelligently and accurately and in real time.

Keywords: port, intelligent, heavy metal pollution in seawater, monitoring and warning equipment, control

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INTRODUCTION

Water resource is an indispensable resource type in human existence and social production and development. In recent years, the phenomenon of water resources shortage has become more and more serious in China, so our country has increased investment in water resources protection. Heavy metal pollution is a diffusive phenomenon of water resources pollution, which has always been the focus of water pollution control in China. Heavy metal pollution monitoring can provide a detailed and reliable basis for pollution control, so it is very important to explore the monitoring technology of heavy metal pollution in water environment (Zhang and Zhang 2018, Gunduz et al. 2016). The pollution of heavy metals in marine ports can be divided into anthropogenic factors and natural factors according to their sources. Human factors include human life and the port produced by production releases heavy metals into the environment. The natural factor is that heavy metals buried in underground ports are discharged into seawater due to non-human geological activities or microbial biosynthesis. After entering the sea, heavy metals float in the sea rapidly, form oil film, block the air dissolution and release, inhibit the photosynthesis of phytoplankton in the water, reduce the oxygen content in the water gradually, and asphyxiate the fish and shrimp shellfish. The light aromatics and their derivatives in the heavy metal composition of the port are very harmful to marine life, even fatal (Fan et al. 2018). Port heavy metal pollution will not only affect the quality of seawater, but also affect the marine ecological environment and organisms, and even harm human beings.

Traditionally, the main methods for monitoring the pollution of heavy metals in port seawater include visual detection method, seawater sampling method, real-time

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tracking monitoring method. Combined with intelligent software analysis, real-time detection and monitoring of heavy metal pollution in port seawater have been realized (Li et al. 2017), and some research results have been obtained. Among them, in reference (Ramos-Llorden et al. 2015), an automatic gain control method based on photomultiplier tube is proposed to design the control system of monitoring and warning equipment for heavy metal pollution in port seawater. The automatic gain control of random sampling ultra high resolution sea water vision imaging, combined with computer image processing technology, is used to monitor the pollution of sea water in ports. However, the monitoring effect of the system is not good when the dispersion of pollutants is large. In reference (Alfaro and Vilanovab 2013), a kind of monitoring and locating technology of heavy metal pollution in port seawater combined with TD-SCDMA pollution monitoring and DOA-TOA positioning technology is proposed to improve the intelligent level of automatic location of pollution monitoring. However, the method is prone to drift distortion in the design of the core control module. In order to solve the above problems, this paper presents an optimized design method of intelligent monitoring and warning equipment for heavy metal pollution in port based on dual-16-bit fixed-point DSP control. Firstly, the visual and chemical detection design of pollution source is carried out. Then the hardware modularization design of the system is carried out. Finally, the experimental test is carried out, and the effective conclusion is drawn.

MATERIAL AND METHODS

System Overall Design

In order to realize the optimal design of the intelligent monitoring and warning equipment for the sea metal pollution in the port, the detection model of the heavy metal pollution in the port sea water is first constructed, and the real-time sampling of the heavy metal pollution material in the port is carried out. The pollution of heavy metal pollutants in port seawater was detected by both visual analysis and chemical analysis (Bayati and Tavanaie 2018, Deng and Lin 2011). The intelligent marine heavy metal pollution monitoring and warning equipment in the port is based on the video monitoring of the sea heavy metal pollution area in the port and the sea water sampling detection. The real-time trigger PXI-6713 is used to collect the image and video information of the area polluted by sea water heavy metals in the port, and in the identification system of the heavy metal pollution in the port, the intelligent heavy metal pollution of sea water in the port is studied.

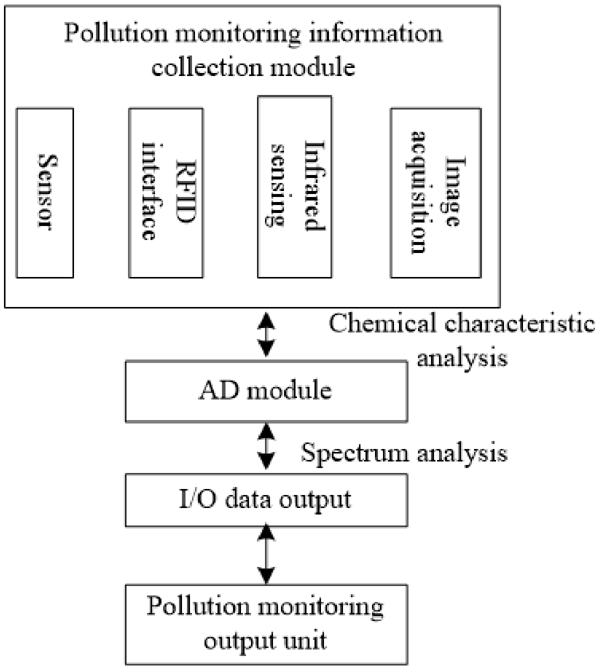

Fig. 1. Structural diagram of intelligent detection principle for heavy metal pollution in sea water in port

The spectral features of heavy metal pollutants in port seawater are extracted by video frame coding, and the marine video and image collected in the field are encoded to extract the abnormal features of sea water (Xia et al. 2013). The difference between the polluted area image and the normal area image is analyzed, the chemical spectrum analysis of the sampling of the polluted matter in seawater is carried out, and the detection of the pollution concentration and the pollution substance is carried out by the combination of the image analysis and the spectral analysis method. According to the above principle, the principle structure diagram of the intelligent monitoring and warning equipment control system of sea metal pollution in port is shown in **Fig. 1**.

Analysis of the Overall Design Framework of the System

In this paper, a design method of intelligent marine heavy metal pollution monitoring and warning equipment based on embedded Linux is presented. The main function modules of the system include ocean image acquisition and seawater sampling, image video coding module, external clock module, image information conversion module, pollution material feature extraction module, local bus module, data output module, man-machine interaction module and visual remote control module, etc. The overall architecture of the system is shown in **Fig. 2**.

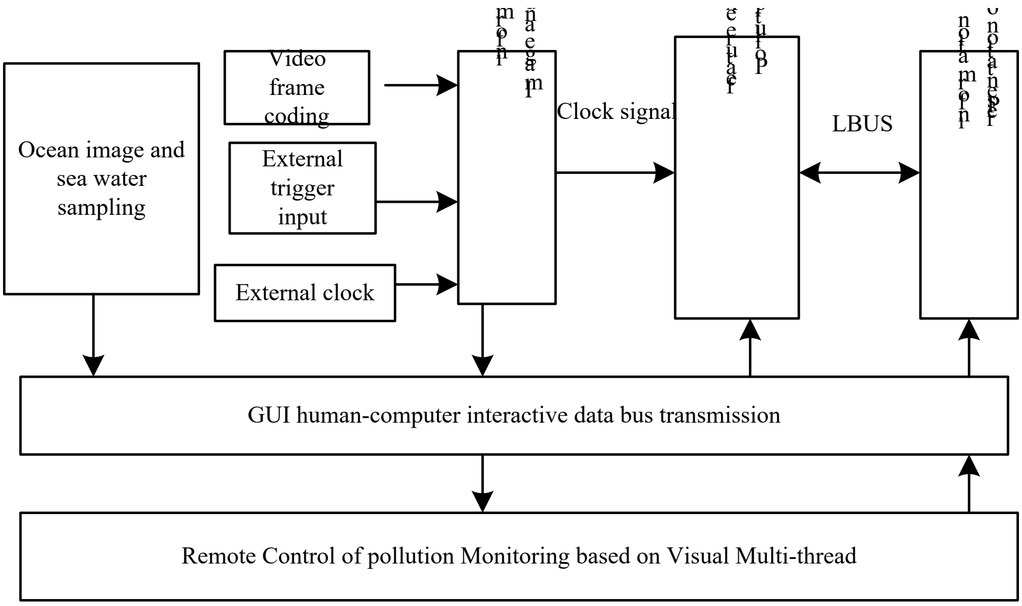

Fig. 2. Block diagram of the overall design framework of the system

According to the overall design framework of the system in **Fig. 2**, the functional composition and structure of the monitoring and warning equipment for monitoring and warning of heavy metal pollution in port seawater are analyzed (Gerami and Saidi-Mehrabad 2017, Mardones and Fuentes 2017, Xia et al. 2012). Firstly, the 3D laser scanning image of the intelligent sea metal pollution in the port is processed and the feature is extracted. The external bus is triggered by the video capture of the polluted area of the sea water in the port, and the combination of the video frame coding and the video frame coding. Combined with chemical spectral analysis method, the chemical characteristics of heavy metal pollutants in port seawater were analyzed. DSP and logic programmable PLC are used to transform the visual sampling video information of heavy metal pollution in port seawater. The video acquisition module, core control module and man-machine interaction module are established for real-time monitoring of sea metal pollution in port. The real-time video image acquisition method is used to collect and analyze the visual characteristics of the polluted area of sea water in port. The output of I/O data and the spectral analysis of pollution source are realized, and the real-time monitoring of the heavy metal pollution of sea water in port is realized (Cui and Zhang 2015).

Hardware Design and Implementation of the System

On the basis of the overall design frame and function modularization analysis of the intelligent monitoring and warning equipment for sea metal pollution in port, the hardware design of the system is carried out. The hardware design of the system is based on the combination of module design and integrated design. The pollution of heavy metal pollutants in port seawater was detected by both visual and chemical analysis methods (Sun et al. 2016). In the hardware modularization design of the system, it mainly collects the information of the heavy metal pollution material in the port sea water, and the pattern recognition module of the pollution substance detection. The remote terminal communication transmission control module and the man-machine interaction module circuit are designed in detail, and the MUX101 program-controlled drive module is designed to alarm and control the heavy metal pollution in the port intelligently (Deng et al. 2016, Kang et al. 2018). Finally, the integrated design of the system is completed in ITU-656 PPI mode and general PPI mode. The hardware modularization design of heavy metal pollution monitoring and warning equipment control system for port seawater is described as follows.

Sensing information collection module of heavy metal pollution material in port seawater

AD module is used to collect the information of heavy metal pollution in port, which is mainly used to collect the chemical characteristics and infrared spectrum of sea water, and to collect the video image with laser sensor. The sensor information collection module of heavy metal pollution in port seawater is designed by LOCAL bus of PCI9054. ARM is used as the core control unit for video conversion and angle switching between the port seawater heavy metal

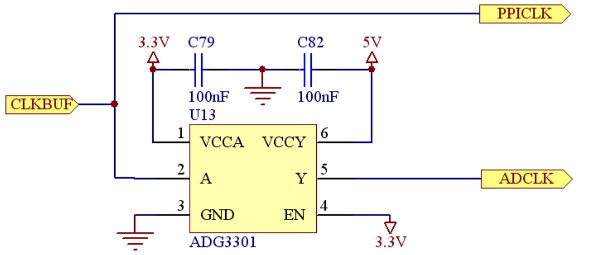

Fig. 3. Design of sensor information collection module for heavy metal pollutants in port sea water

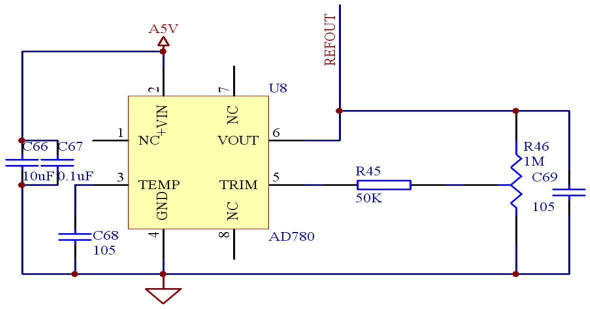

Fig. 4. Circuit of pattern recognition module for detection of heavy metal contaminants in port seawater

pollution site and the port seawater heavy metal pollution video monitoring. The 100 MHz backplane clock is designed to monitor and measure the chemical characteristics of sea water in real time (Guan and Pang 2018). The AD module circuit of the intelligent marine heavy metal pollution monitoring and warning equipment control system designed in this paper is shown in **Fig. 3**.

Pattern recognition module for detection of pollutants

The pattern recognition module of pollution material detection is the core control module of the monitoring and warning equipment for the pollution of seawater heavy metals in the port. The MUX101 program-controlled switch control method is used to alarm and control the heavy metal pollution in the port intelligently. When the input voltage is 4 V-36 V, the decoupling capacitors of 10 s and 0.1 G are added as load capacitors, the high voltage is controlled by AD780 dual serial port clock, and the temperature drift correction is carried out by setting the RC filter circuit with intersecting intersections (Belmonte et al. 2018, Hu et al. 2018). The design of PXI-8155 controller under embedded Linux is carried out, and the instruction is issued to the AD control system of the monitoring and warning equipment for monitoring and warning of heavy metal pollution in port seawater. The output reference voltage of OUTA pin is 2.5 V. The maximum 16-bit video coding/decoding of heavy metal pollution monitoring in port seawater can be carried out, and the

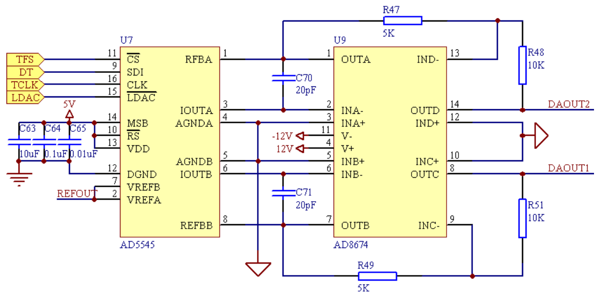

Fig. 5. Circuit design of communication control module for remote terminal

circuit design of the pattern recognition module for the detection of heavy metal pollution in port seawater is shown in **Fig. 4**.

Remote terminal communication transmission control module

The communication and control module of remote terminal is the function of communication and instruction transmission of host computer for real-time monitoring of heavy metal pollution in port seawater. First, the sampling rate generator of serial port 0 is started and the serial port is sent and received. The remote terminal communication transmission control module can carry out the input and output of 16 bit data. The control system of the monitoring and warning equipment for heavy metal pollution in port sea water outputs the frame synchronization signal of DSP from CS and the serial port clock of DSP from CLK. The current limiting protection circuit is designed by using ADUM1201 and PCA82C250. The upper computer communication string is set on the OUTA pin of AD8674, and connected to the host computer through a 5 resistor at the entrance of the power supply, which controls the rise and fall of the signal (Ma and Yu 2018). The circuit design of the remote terminal communication transmission control module of the intelligent monitoring and warning equipment for sea metal pollution in port is shown in **Fig. 5**.

Man-machine interaction module

The man-machine interaction module is used to realize the remote control function of pollution monitoring (Cai et al. 2018, Liu 2018). The program loading and interface design of the human-computer interaction module are carried out by cross-compiling method. The design result is shown in **Fig. 6**.

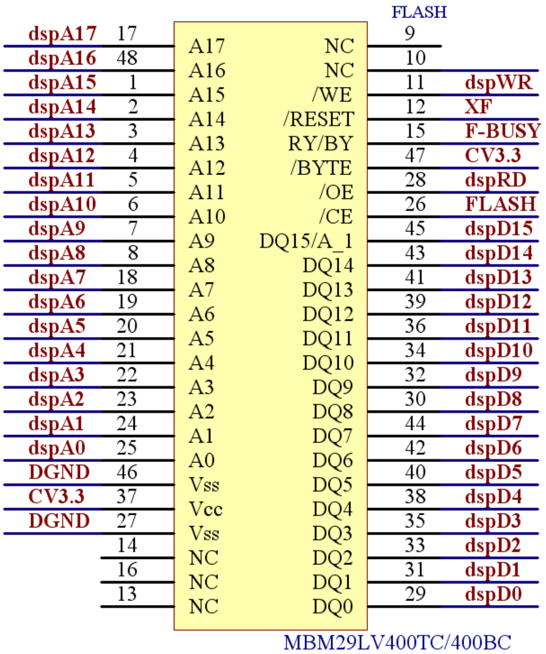

Fig. 6. Design of human-computer interface

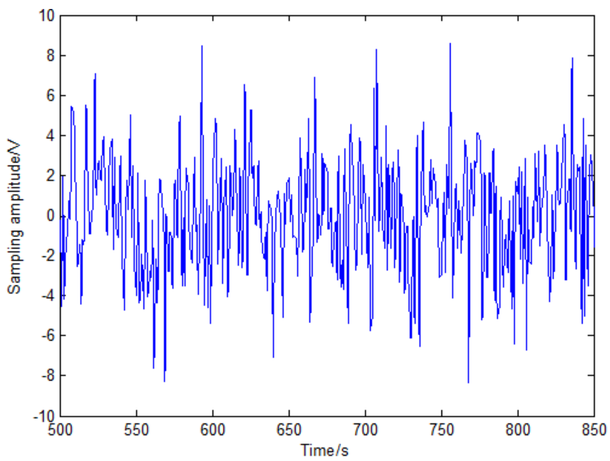

Fig. 7. Data analysis of real-time monitoring of heavy metal pollution in port seawater

RESULTS

In order to test the application performance of this method in realizing the real time monitoring of sea metal pollution in port, the experiment test and analysis are carried out, and the hardware circuit of the system is debugged. Through the development of software, the real-time monitoring and identification of heavy metal pollution in port seawater can be realized. The marine image satellite data and sea water sampling data of HP E1562E in the area polluted by sea water heavy metals in SCSI port are read, and the information fusion and monitoring identification are carried out. The result of data analysis is shown in **Fig. 7**.

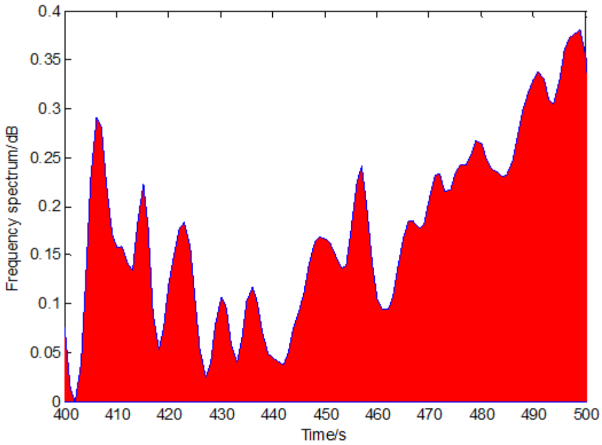

Fig. 8. Spectral analysis of real-time monitoring of heavy metal pollution in port seawater

Table 1. Comparison of detection accuracy of heavy metal pollution in port seawater

SNR	Method in this article	PID Feedback Adjustment Method
-10	0.987	0.854
-5	0.993	0.890
0	0.996	0.921
5	1	0.943
10	1	0.965

Taking the sampling data analyzed in **Fig. 7** as the test sample, the pollution detection and analysis are carried out, and the spectrum analysis results of real-time monitoring of heavy metal pollution in port seawater are obtained as shown in **Fig. 8**.

Compared with the traditional method, the accuracy of the pollution detection is compared with the results in **Table 1**. The results of **Table 1** show that the method proposed in this paper is accurate and real-time in detecting the pollution of heavy metals in port seawater, and the real-time monitoring of heavy metal pollution in port seawater is realized.

DISCUSSION

Compared with photochemical monitoring and other methods, analysis of sea water samples in a certain sea area, we can know whether the sea water is polluted by petroleum hydrocarbon. The commonly used methods are gravimetric method, which is the weight of the extract which is difficult to volatilize after evaporating the extractant. It is suitable for the measurement of high concentration wastewater such as pollution source and samples in the area of serious pollution of petroleum hydrocarbon such as sediment in the harbor. Its advantage is that it is not limited by the oil mark. Shortcomings are complicated procedures, large errors; Ultraviolet spectrophotometry is used to measure conjugated polyolefin (225 nm) and aromatics (254 nm) extracted from seawater. The disadvantage is limited by the oil mark; Fluorescence spectrophotometry can be used to measure unsaturated compounds and aromatics in the extracts. Its advantages are easy to operate, which is very beneficial to the measurement of low concentration samples, but the oil content is limited by the oil standard. It also depends on the processes of excitation and emission wavelengths, as well as extraction and evaporation, which are suitable for the determination of petroleum hydrocarbons in ocean water and in less polluted seawater, as well as petroleum hydrocarbons and sediments in organisms, especially in biological samples, Small interference by pigment, easy and time saving operation; Infrared method (C-H2 stretching frequency, 2930-1) has the advantage that it is not limited by oil standard generally, and its shortcoming is low sensitivity. It is mainly used for the determination of oil and water separation results of oil refinery wastewater, pollution source and ship oil and water. Packed column gas chromatography can be used to determine the ratio of total hydrocarbon, single n-alkane, n-alkane and isoprene in the sample, but the separation effect is poor. Silica glass capillary column gas chromatography was used to determine the degree of separation of aromatics on a single n-alkane column, on a silica gel column or on an aluminized aluminum column, and on a silica gel column filled with alumina, the degree of separation was higher than that on a packed column. But the operation is difficult, the analysis time is long; Color/mass spectrometry, which is a method of on-line application of the ideal separation device (gas chromatograph) and the most superior identification tool (mass spectrometer), especially when modern data processing systems are compatible with it, Both qualitative and quantitative analysis are very convenient for the determination of single components and pre-selected components. Monitoring of aquatic organisms and analysis of petroleum hydrocarbon content in organisms can reveal the influence of petroleum hydrocarbon pollution on organisms in a certain sea area. Based on the above analysis, the intelligent monitoring and warning equipment for heavy metal pollution of sea water in port is controlled by the method of this paper, which has a good intelligence and high accuracy for pollution monitoring.

CONCLUSIONS

In this paper, the intelligent marine heavy metal pollution monitoring and warning equipment control system is designed, and the pollution detection is carried out by visual analysis and chemical analysis. Firstly, the system structure and principle are analyzed and explained. Then, the sensing information collection module of pollution monitoring and warning equipment control system and the pattern recognition module of pollution substance detection are introduced. The remote terminal communication transmission control module and man-machine interaction module are designed in detail, and the MUX101 program-controlled driving module is designed to alarm and control the heavy metal pollution in the port intelligently. The software development and design of the pollution monitoring and warning equipment control system is carried out under the embedded kernel. The test results show that the system can be used to monitor the pollution of sea water intelligently in port, which has good accuracy and real time performance, and has good application value.

ACKNOWLEDGEMENT

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