A Marine Hydrographic Measurement System

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Abstract. The marine hydrographic measurement system is used to complete the information measurement system of seabed topography, sea water sound velocity profile, flow velocity, flow direction profile, pressure and so on. In this paper, a marine hydrographic measurement system is described.

Keywords: Hydrographic Measurement, Multibeam Sounding Device, CTD; ADCP

1. Introduction
The marine hydrographic measurement system is used to complete the information measurement system of seabed topography, sea water sound velocity profile, flow velocity, flow direction profile, pressure and so on [1]. The system is applied to marine engineering, marine resources investigation, river measurement, salvage and life saving, port construction, river dredging, underwater exploration, safe navigation and other fields [2, 3].

2. A Marine Hydrographic Measurement System
The marine hydrographic measurement system is built according to the principle of separation of equipment and display control. The system is divided into operation layer, control processing layer and communication layer.

The equipment corresponding to the operation monitoring layer of the system is the hydrographic survey information integrated console, which includes repeater, central processor, and completes the control and processing functions of system sensors and actuators.

The processing layer of the system includes depth sounder, CTD, ADCP, attitude instrument, RTK GPS display, etc., which can complete the measurement operation function at the system level.

The communication layer of the system adopts Ethernet structure. The system can manage the grid comprehensively, acquire the parameters of sub equipment and control the work of sub equipment through the network [4-5].

See Figure 1 for the composition diagram of system equipment.
Figure 1. Schematic diagram of marine hydrographic measurement system

3. Main Function of the System

3.1. Information Management Capability
The system can measure the temperature and salinity information of the marine profile, and users can get the fine temperature and salt structure of the marine water body and its temporal and spatial characteristics and laws according to the measured information.

The system can also measure the water depth of the seabed area by multi beam, and process the three-dimensional ground map to form the three-dimensional effect map of the seabed topography.

In addition, it can also measure and record the velocity of underwater flow on the sea water profile.

3.2. Data Compatibility
The hydrographic measurement system includes equipments which meet the requirements of international standards and arcs raster format bathymetric data.

The format of information interface is compatible with nema0183 and IEC61162 of International Association of navigation electronics.

3.3. Database Management Capability
The marine hydrographic measurement system supports the functions of hydrological information storage, browsing and retrieval. At the same time, it also supports the query function of hydrological information elements.

The system can store sensor measurement data and process data, and support equipment status recording and query function.

3.4. Display Control
Under the control of the display console of the marine hydrographic measurement system, the parameters of each hydrological sensor can be controlled to complete the measurement of corresponding hydrological parameters.

4. Core Equipments of the System

4.1. Multibeam Sounding Device
The multibeam topographic and geomorphological measurement system has a narrow beam width range. The measurement fan angle of the existing system can be expanded to 150 degrees or even larger, and 100 or even hundreds of beams in the fan can be simultaneously.
In addition, in order to obtain high-precision seabed information, in the multi beam terrain and geomorphology system, in addition to the sub units such as transmitting, receiving and processing of detecting acoustic waves, there are also a variety of auxiliary measuring equipment, such as the surge filter used to provide the differential GPS of geodetic coordinates, the surge filter used to provide the attitude data of measuring ship roll, pitch, heading, heave, etc., which is used to provide the tide level data of the measured sea area Instruments, sound velocity instruments used to provide data of measured sea area sound velocity profile, printers and plotters used to provide output of digital results, etc. Figure 2 shows the schematic diagram of multibeam sounding device.

**Figure 2.** Schematic diagram of multibeam sounding device

4.2. Temperature, Salt and Depth Measurement Instrument

Temperature and salt depth (CTD) is an efficient measurement tool to measure the static parameters (temperature, conductivity, depth) of ocean hydrology, such as high-density, high-precision measurement and sound velocity calculation. The schematic design diagram of CTD is shown in Figure 3.

**Figure 3.** Schematic diagram of CTD

4.3. Acoustic Doppler Current Profiler

According to the principle of acoustic Doppler, Acoustic Doppler Current Profiler (ADCP) is used to measure the vertical profile distribution of water flow by appropriate synthesis method. The velocity
of each water depth unit measured by ADCP is the average velocity of the center of the unit. It can quickly obtain the three-dimensional flow field section of the sea area during navigation.

ADCP uses the principle of Doppler effect to measure the velocity, and uses acoustic transducer as the sensor, the acoustic pulse emitted by the transducer is scattered by the scattering body, such as sediment particles and plankton, which are distributed unevenly in the water, and then received by the transducer. By analyzing the Doppler information of the echo signals of four beams, the velocity and direction of the current are measured. ADCP has the characteristics of high resolution, direct measurement of cross-section velocity profile, undisturbed flow field, short test duration and large measurement range [6].

In the development of core equipments, we use the integrated design of transducer and flow measurement array, in which the designed watertight cylindrical shell can withstand 200m water pressure, and all relevant power amplification circuits and receiver circuits are placed in the watertight shell.

The ADCP is fixed in the bow to measure the velocity of flow, and the multi beam transducer array is installed in the middle of the ship. The ADCP is connected to the signal processing box, and the multi beam transducer array is displayed and controlled by connecting a PC.

4.4. Attitude Instrument
The function of the attitude instrument is to compensate the measurement error caused by the sway of the hull itself in the measurement process. It should be installed in the same cabin with the electronic cabinet, and the fixed installation mode should be adopted.

4.5. RTK GPS
The carrier phase observation value must be used in high-precision GPS measurement. RTK Positioning Technology is the fact dynamic positioning technology based on the carrier phase observation value. It can provide the three-dimensional positioning results of the measuring station in the specified coordinate system in real time, and achieve centimeter level accuracy. The GPS mobile station needs to be installed on the hull for measurement.

5. Simulation and Results
Through the marine hydrographic measurement system, we can measure the underwater three-dimensional topographic map in real time. After processing, the underwater landform map can be obtained, as shown in Figure 4.

![Figure 4. Underwater landform map](image_url)
In the display interface of the marine hydrographic measurement system, the integrated navigation information of the equipment, such as time, position, attitude, etc., can be displayed simultaneously, which is convenient for observation and analysis. The display interface is shown in Figure 5.

![Figure 5. Display interface of marine hydrographic measurement system](image)

6. Conclusion
In this paper, we propose a marine hydrographic measurement system, including multi beam sounding device, CTD, ADCP and other core equipments. The system can measure and display the topography and related navigation parameters in real time, which is of great significance for the study of rivers, lakes and seas, the prediction of natural disasters and hydrological monitoring.

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