A Petroleum Platform-Based Radar Wave and Tide Information Measurement and Transmission System

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Abstract. In recent years, the ocean observation technology has made considerable progress with the state's strong support for the marine industry in China. The oil platform has stable power output and reliable structural support. The measurement parameters are transmitted to the data processing control center through radar wave and tide sensor installed on the platform, and the measurement data are transmitted to the marine environment monitoring and forecasting center using the Beidou satellite communication device.

1. Introduction
In recent years, the ocean observation technology has made considerable progress with the state's strong support for the marine industry in China. This plays an inestimable role in improving the monitoring capabilities of the marine environment, promoting the prediction of marine disasters, carrying out the marine environmental protection, and developing the marine economy. Offshore oil platforms are facilities for the exploitation of oil and gas on the sea. They are distributed in various regions near or far from the sea. Whether they are fixed or mobile, these platforms have very stable structural support. It is therefore of great significance to use it as a "natural" carrier on the ocean to monitor the marine environment.

There are many domestic and abroad methods to measure wave and tidal information in the sea area where the ocean platform is located, such as measuring tide levels by float-type tide gauges or GPS technology; using CCD sensors; measuring wave using wave buoys or waves; but there are certain defects in various methods from the point of view of the current technical methods for measuring wave and tides. The floater-type needs to build specially a tidal survey well, and the economic cost is too high; the accuracy of GPS technology is relatively high, but its resolution is limited. The acquisition of signals of tide measured by CCD sensor at night is unstable; poor long-term stability makes it difficult to maintain wave buoys; moreover, it has become increasingly important to measure tide levels and wave
information in the sea area where oil platforms are located as the storm surges frequently occur nowadays. It is therefore necessary to provide a petroleum platform-based wave and tide measurement transmission system developed using the radar-type wave measurement principle, which is a stable carrier.

2. How the system works
The radar wave and tide sensor used by the system to measure wave and tide is a non-contact microwave radar. It observes by receiving the mirror-reflected echo signal from the sea level of the lower viewpoint. The sensor emits vertically a narrow wave to the sea level at a certain frequency. The distance from the equipment to the sea level, h, is then calculated according to Formula 1, by calculating the time delay \( \Delta \tau \) of the echo arrival. The measured tide level value is the installation height \( H \) of the equipment minus the distance \( h \) from the sea level. The time series of sea level fluctuations is then converted into time series of wave amplitudes to obtain the wave spectrum and parameters.

Formula 1: \( h = \frac{c \Delta \tau}{2} \) where \( c \) is the speed of light.

Next, the data processing control module calculates and stores the wave data collected by the radar sensor and then sends it to the wireless communication module. The wireless communication module transmits the collection data of wave and tide to the terminal receiving device by the Beidou satellite signal after receiving the data sent from the data processing control module.

3. System composition
The system mainly consists of four parts, including the host and installation station of radar wave and tide instrument, the data processing control module, the wireless communication module, and the terminal receiving device. The entire system diagram is shown below:

The host of wave and tide instrument used in this system is WaveRadar linear sweep radar sensor produced by Swedish Rosemount Company. It is installed on the outdoor deck of the oil platform by a specific installation platform (see Figure 2) via a holding clamp. It should be noted that the installation platform consists of supporting rods, beams, channel steels, etc. The installation bracket is designed for the special installation environment of the oil platform to facilitate disassembly and maintenance in the later period.
Figure 2. Installation Platform of Radar Wave and Tide Instrument

The data processing control module of the system is an embedded industrial control computer system. It algorithmically processes certainly the tide data collected by radar wave and tide sensors according to the observation methods of the sea wave factors in the Specification for Offshore Observations. It stores and shows the processing results in the industrial control computer, and sends it to the remote receiving module. Finally, it can be used for our research after being processed by the receiving software of the upper computer.

Table 1. Part of Wave Data Measured by the Wave and Tide Information Measurement System in Some Region of the North China Sea

| Hour | Hmax (m) | T (s) | H1/10 (m) | T (s) | Hs (m) | T (s) | HA (m) | T (s) |
|------|----------|-------|-----------|-------|--------|-------|--------|-------|
| 00   | 0.50     | 3.25  | 0.43      | 3.23  | 0.35   | 3.52  | 0.24   | 3.22  |
| 01   | 0.55     | 3.25  | 0.43      | 3.04  | 0.35   | 3.22  | 0.25   | 3.05  |
| 02   | 0.65     | 2.25  | 0.54      | 2.69  | 0.46   | 2.70  | 0.33   | 2.82  |
| 03   | 0.83     | 3.50  | 0.65      | 3.10  | 0.55   | 3.20  | 0.40   | 3.02  |
| 04   | 0.65     | 3.50  | 0.56      | 3.42  | 0.46   | 3.29  | 0.33   | 3.24  |
| 05   | 0.58     | 2.75  | 0.50      | 3.38  | 0.41   | 3.42  | 0.29   | 3.37  |
| 06   | 0.70     | 3.75  | 0.56      | 4.06  | 0.48   | 3.78  | 0.35   | 3.50  |
| 07   | 0.83     | 3.75  | 0.72      | 4.02  | 0.61   | 3.90  | 0.42   | 3.62  |
| 08   | 1.09     | 3.75  | 0.77      | 4.21  | 0.63   | 4.00  | 0.43   | 3.70  |
| 09   | 0.91     | 4.75  | 0.69      | 4.35  | 0.55   | 4.37  | 0.37   | 4.05  |

4. Conclusion
The oil platform has stable power output and reliable structural support. The measurement parameters are transmitted to the data processing control center through radar wave and tide sensor installed on the platform, and the measurement data are transmitted to the marine environment monitoring and forecasting center using the Beidou satellite communication device. It also satisfies the acquisition demand of the oil platform for real-time wave information on the sea level in the region, and ensures the long-term, real-time, continuity, and stability of wave measurements.
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