An Ocean Stereo Telemetry System Based on PC104 Industrial Control Computer and Iridium Communication

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ABSTRACT

To monitor ocean resources and environment, we develop an ocean stereo telemetry system built on a PC104 industrial control computer, which is carried by a buoy on the ocean. All monitoring instruments communicate with the computer by six serial ports in virtue of time division multiple access and are synchronized by GPS time to collect data. All monitoring data is archived and compressed in format of RINEX (Receiver Independent Exchange). The uploading data and downloading control command to and from monitoring center is transferred by Iridium communication in automatic retransmission request and broken-point continuing mechanism.

KEYWORDS

Ocean Stereo Telemetry, GPS, Iridium Communication, Automatic Retransmission Request, Broken-point Continuing transmission

INTRODUCTION

Rich resources exist in the ocean. Ocean monitoring is beneficial and important. But for ocean stereo monitoring that is far over 50 kilometers from the land, it is difficult because of its terrible environment, heavy causticity, and lack of general power supply and communication infrastructure. It requires all monitoring instruments with low power loss, high stability and reliability. As a result, PC104 industrial control computer is selected as a monitoring platform on the ocean because of its good performance. Iridium communication is adopted because of its high data transmitting speed and wide network coverage range. At the same time, to overcome high drop-off rate and high bit error rate in communication

procedure, automatic retransmission request and broken-point continuing transmission mechanism is applied; and to improve communication efficiency, all monitoring data is archived and compressed in format of RINEX.

In this paper, we first explain the principle and architecture of the system, and then introduce the design of monitoring platform and Iridium communication.

SYSTEM OVERVIEW

The whole ocean stereo telemetry system is composed of three parts: an ocean stereo monitoring platform, an Iridium communication system, a monitoring center, as illustrated in the Figure 1. Through different monitoring instruments, the monitoring platform can monitor different ocean resources and environment, such as ocean tide, seawater surface, seabed, etc. Iridium communication system provides data transmission link between the monitoring platform and the monitoring center. First, the Iridium handset of monitoring platform will dial and initiate a connection with Iridium gateway through Iridium satellite constellation, the switch at the gateway then will route the call through PSTN to a modem of the monitoring center. Once connected and a session has been established, data transmission will start. The monitoring center will receive the monitoring data, and download the control command to the appointed monitoring instruments from the downlink as need.

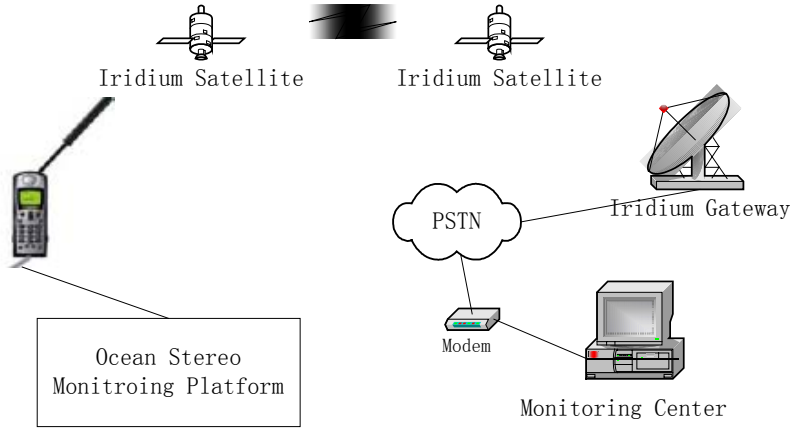

Figure 1 the ocean stereo telemetry system architecture

DESIGN OF OCEAN STEREO MINITORING PLATFORM

The monitoring platform is carried with a buoy on the ocean; the solar battery is under control of a power control instrument to supply power to all devices; the PC104 industrial control computer acts as the control core of the platform, its six RS 232 serial ports are under control of the serial port switch controlled by its parallel port to communicate with other monitoring instruments in virtue of time division multiple access (namely, COM1~COM6), as illustrated in Figure 2.

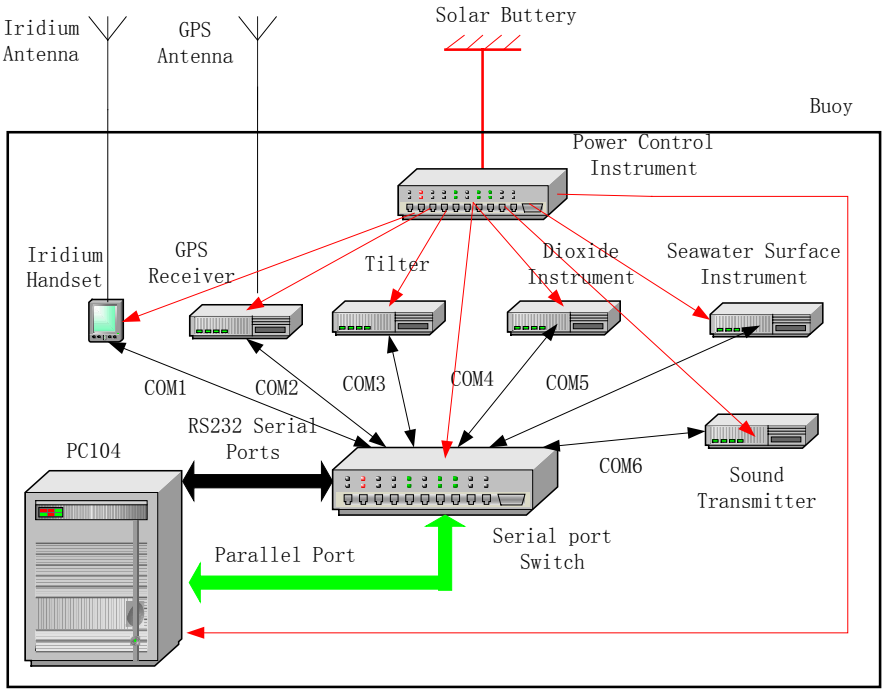

Figure 2 the hardware architecture of the ocean stereo monitoring platform

In these serial ports, COM1 is connected to an Iridium handset, which provides data service and is used to upload data and download control commands to and from the monitoring center. COM2 is connected to a differential GPS receiver, which is used to measure the altitude of the GPS antenna on the top of the buoy. COM3 is connected to a tilter, which is used to measure the buoy pitch and roll. As a result, the ocean surface altitude under the buoy is computed from the buoy top altitude, buoy pitch and roll. Thus, ocean tide monitoring is achieved. COM4 is connected to a dioxide instrument, which is used to measure carbon dioxide of seawater and atmosphere. COM5 is connected to a seawater surface instrument, which is used to measure the interface between seawater surface and atmosphere. COM6 is connected to a sound transmitter, which is used to transmit control commands and data to and from these monitoring instruments on the seabed. The communication between PC104 and other monitoring instruments conforms to RS232 serial communication protocol. Interrupt mechanism is used by DTE to receive data; and inquiring mechanism is used to send data. Once received data packet from PC104, these monitoring instruments will analyze the data packet type, if the data packet is an collecting data command, it will collect data and return monitoring data in given time; if the data packet is a control command, it will execute the command and return the executed result in given time.

The software of the whole system is designed in modularized way. It runs as follows: the system setup (such as serial port property, sample frequency, etc.) is initiated firstly, then the update rate of GPS receiver is configured before the data collection. When GPS data and Tilter data collection has finished together, the system will close GPS output and begin to collect other data. In this process, the internal clock time of all monitoring devices are timely synchronized by GPS time. When all data collection has been finished, all data is

archived and compressed in format of RINEX. After compress has been realized successfully, data transmission procedure will begin in return. When data transmission has finished, if the system does not exit, it will initiate a new monitoring loop, as illustrated in Figure 3. To improve system stability and reliability, the system will save its current state before every module begin to execute, and open a software watchdog to limit the normal executing time. If the program module does not return in given time, the system will reset and continue its task according to the stored system state.

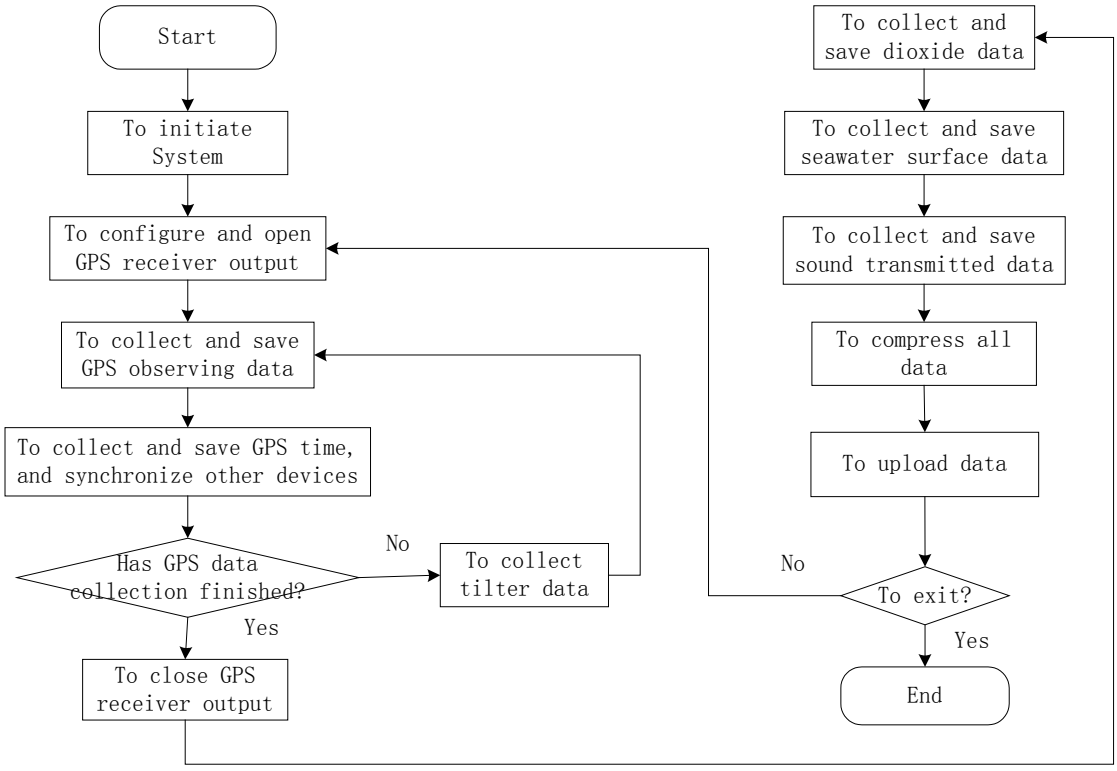

Figure 3 the work flow chart of the monitoring platform

DESIGN OF IRIDIUM COMMUNICATION

From the perspective of PC104, the Iridium handset is an external modem, which provides data service and supports AT command. We can use it just as we use the modem to dial a call through PSTN. The only differences are that the dialed telephone number must conform to the international dialing pattern used by Iridium.

To overcome high drop off rate and high bit error rate in Iridium communication process, automatic retransmission request and broken-point continuing transmission mechanism is used. All data are transmitted in data frame, which is illustrated as Table 1. The frame head and frame end is used to communicate in synchronization between sending DTE and receiving DTE. Serial number is used by sending DTE to sign the data frame, and by

receiving DTE to request retransmission when bit error has been found; Checksum is used to find bit error.

Table 1 data frame format

Frame head	Serial number	Type	Data length	Data	Checksum	Frame end

Under broken-point continuing transmission mechanism, when sends a new data frame, sending DTE will save the new serial number and wait ACK response from receiving DTE in given time. Whether wait time is out or the sending DTE receives drop off signal from its DCE, the DTE will initiate a new call and reestablish communication link to continue its transmission from the position of the saved data frame.

The software of Iridium communication is also designed in module way, as illustrated in Figure 4. The program runs as follows: it first begin to dial and establish communication link when the program is on; when the link has been established successfully, it begin to get a new data frame and transmit in automatic retransmission request and broken-point continuing transmission mechanism. After all data has been transmitted, the sending DTE will hang up its modem.

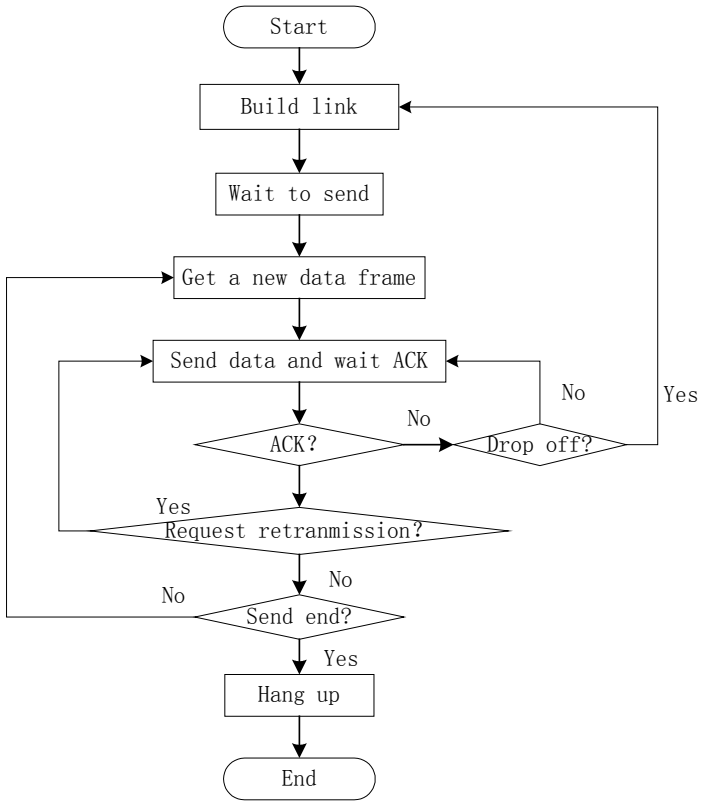

Figure 4 the flow chart of Iridium communication

SYSTEM TEST

The first test of this ocean stereo monitoring system started in 21,Jan 2005, on the ocean near QingDao international harbor. The sampling periods of these monitoring instruments are listed in Table 2. The baud rate of Iridium communications is 2400 bps. Experiments show that the tide measurement precision of this system reached 2 centimeters, others monitoring function also run well. The retransmission mechanism proposed in this paper works very well from the data analysis result.

Table 2 sampling periods

Items	The sampling periods
GPS observing data	120 seconds
GPS time data	10 seconds
Tilter data	120 seconds
Dioxide data	3 hours
Seawater surface data	3 hours
Sound transmission data	3 hours

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