Study of Real-time Monitoring for Ship-borne Antenna Locking Mechanism

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Abstract: In consideration of the current ship-borne antenna locking system, a measuring system for motor current measurement and locking pin stroke is designed to achieve the purpose of real-time monitoring the status of the locking system. The current detection sensor and distance measurement sensor are used to realize the real-time measurement of the distance and the motor current for the locking pin. The remote transmission of the field measurement data is realized by the single chip computer and the serial communication module. The upper computer can analyze and graphically display the data through the designed software, thus realizing the real-time monitoring and improving the reliability of the system.

1. Introduction

The ship-borne antenna uses a three-axis tracking system. When locking, a special mechanical locking mechanism is needed to prevent the damage of the antenna structure caused by the ship's rolling and achieve the purpose of protecting the antenna structure. The existing locking system uses AC motor to drive the reducer gear, and then reducer gear to drive the locking pin, so as to realize the advancement and retrogression of the locking pin. At the end of the cross axle of the antenna, a locking hole matching the locking pin is provided. Only when the pitch axis and the cross axle of the antenna are within a specific angle range, can the locking pin be locked or unlocked smoothly. Locking system is at the antenna end, but in actual use, personnel cannot be disposed of on-site, which makes the operator cannot understand the real-time working state of the locking motor and pin. Especially because of ship rolling, the antenna axis is offset, and the locking pin cannot enter the locking hole smoothly. At this time, the locking motor is still running, which easily leads to mechanical structure failure of the locking system.

To solve this problem, it is particularly necessary to design a real-time monitoring system for the state of the lock mechanism of ship-borne antenna. In this paper, a current detecting sensor is added to the power supply circuit of the motor to monitor the working current of the motor in real time. An ultrasonic distance measuring sensor is installed to monitor the real-time travel of the locking pin in the direction of the travel direction of the locking pin. The real-time data of the two sensors are processed by a single chip computer on the spot and sent to the remote host computer by serial communication. The remote upper computer can parse the serial port data in real time, and after unpacking it, display the working current of the motor and the stroke of the locking pin in a real-time graphical way.

2. System Architecture Design

The real-time monitoring system of antenna locking mechanism is composed of hardware and software system design, and its composition principle is shown in Fig.1. The hardware part mainly realizes the detection of the field current and distance. The MCU realizes the processing of the detection data, and sends it to the serial communication module after encapsulation to realize the long-distance transmission of the field data. The software part is composed of the software designed in the remote host computer, which realizes the unpacking and graphical display of the field data. The

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whole system takes the single chip computer as the core processing module to realize the coordination between the sensor data and the serial communication module.

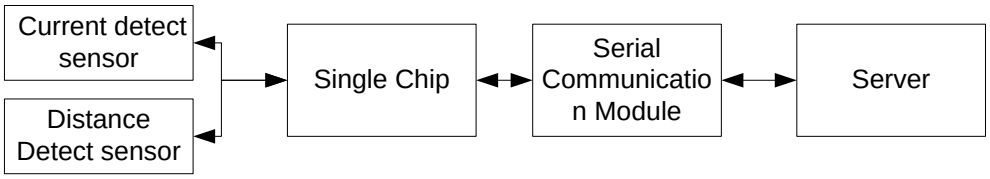

Figure 1. Software and hardware design of the system

3. System Hardware Design

The hardware design focuses on the detection of the working current of AC motor and the travel distance of lock pin. Because the lockout pin power motor works in AC mode, an electronic current transformer [2] can be installed in the working circuit of the motor. When the motor works, there will be alternating current in the circuit, and then the current transformer can induce the current, which can reflect the real-time working current of the motor. The distance detection sensor uses the ultrasonic distance measurement sensor, fixes the distance measurement sensor on the distal end of the travel direction of the locking pin axis through a fixed device, adjusts the distance appropriately, so as to meet the normal operation of the distance sensor, and can not affect the normal operation of the locking pin. The system uses SR-04 ultrasonic sensor, which uses IO (Input/Output) to trigger ranging and trigger high-level signals lasting more than 10 mu s [3]. The sensor module automatically sends 8 40KHz square waves and outputs IO high-level by detecting the return signal. The duration of high-level is the time from the test point to the return point of the ultrasonic wave. Through the distance conversion formula:

$$dis\tan ce = \left(HighLevelDuration \quad * \quad 340m/s \right)/2 . \tag{1}$$

The actual distance of field measurement can be obtained.

MCU can use common AVC development board, one has abundant interface resources, which is conducive to access a variety of interface modules; the other can use on-board serial communication interface to achieve remote data transmission. Serial communication is a full duplex communication mode, which can receive and transmit data at the same time. It can also set its data transmission rate and frame format through software, so it is easy to use. The control registers used in MCU serial communication include serial control registers SCON, power control registers PCON and interrupt admission control registers IE etc [4]. In addition, in order to carry out data communication between MCU and remote host computer, it is necessary to set the same communication parameters. The system sets the communication baud rate to 9600 bps, without verification, and uses 8-bit data bit and 1-stop bit.

4. System Software Design

The software includes the software running in the MCU and the processing software module running in the remote server. The former realizes the data envelope and serial communication settings for the field acquisition, while the latter completes the data unpacking processing and graphical display functions for the serial transmission. The process flow of remote server software is shown in Fig.2.

Server-side serial communication can be realized by using the serial communication control MSComm of VC++ [5]. After setting the properties of communication control, we need to add event response code. MSComm control has only one event, that is, OnComm event. When a communication event or error occurs in the MSComm control, the value of the CommEvent attribute will change, and then trigger the OnComm event[6]. Processors in different situations can be written

according to the value of the CommEvent attribute in the response code segment of the OnComm event.

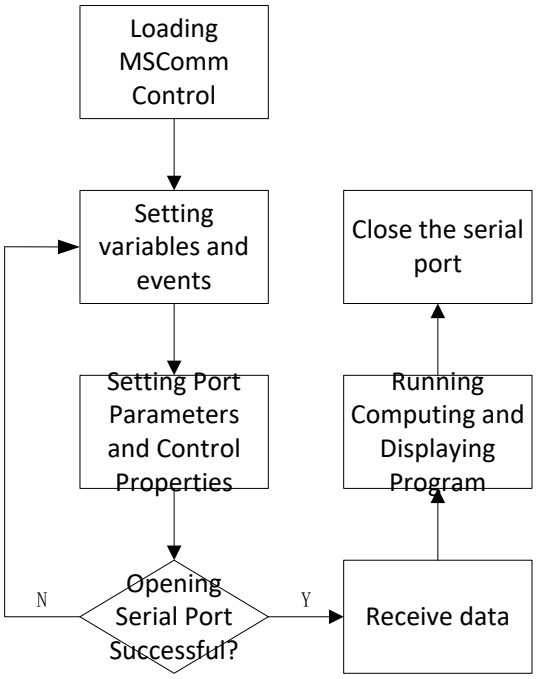

Figure 2. Processing flow of remote software in the system

MSComm control provides two methods to deal with communication, namely event-driven method and query sending method. This paper adopts event-driven method. The main steps of using MSComm control to design serial port program include loading MSComm control, initializing and opening serial port, dealing with serial events, closing serial port, etc.

As a man-machine interface, the remote server processing software needs to be able to collect and process the data collected on the whole site, and analyze and display them. On the main interface of the monitoring software, the time-domain curve composed of motor current data and the running position figure of the locking pin composed of the distance of the locking pin can be displayed, so as to facilitate the operator to view in time.

5. System Test Results

According to the design principle of the antenna locking mechanism condition monitoring system mentioned above, a test circuit based on this principle is built, and an antenna locking mechanism is tested with it, and the actual test results of the system are obtained.

Figure 3. Diagram of systematic test effect

After running the software on the remote server, select the "Open Serial Port" button. If the serial port is successfully opened, the "Serial Port Opened" will pop up. Dialog box, meanwhile, the "Open Serial Port" button on the page becomes gray and unavailable. Thereafter, MSComm control begins to receive data sent by MCU serial port and triggers OnComm event. After a series of calculation and processing, it will display the corresponding graphical display of "Motor Current Curve" and "Lock Bolt Distance". The actual display effect is shown in Fig.3. Among them, the "Motor Current Curve" curve shows the working current of the locking motor changing with time, while the "Lock Bolt Distance" graph shows the actual operating distance of the locking pin.

6. Summary

In this paper, according to the problems existing in the current antenna locking system of ship, it is proposed to increase the current detection sensor to measure the working current of the locking motor and the distance measurement sensor to measure the running distance of the locking pin. The real-time data measured by the two sensors are transmitted to the remote server through serial communication for real-time calculation, processing and graphic display. The actual test shows that the system can effectively reflect the actual operation of the ship-borne antenna locking system and improve the operational reliability of the servo system.

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