A Novel Framework of Integrated Synchronous Flash for Buoys Monitoring System

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Abstract. With the coastal shipping traffic in our country more and more developed, Coastal Waterway Traffic Safety is very important. Traffic lights is an important lights to guarantee the security of shipping, but because of the complex and changing of the offshore environment, therefore to develop a remote control integrated buoy system is particularly important. Through the system, we can grasp the sea channel maritime navigation in real-time, save the buoys maintenance cost to provide a reliable guarantee for maritime traffic safety.

Introduction

The development of Internet technology and mobile communication technology bring to us the novel application. Today we combined the computer network technology, 3G technology and the Pharos telemetry remote control module to realize environmental parameters of pharos monitoring, then use GPS satellite timing as the synchronous timing, with high precision synchronization algorithm to realize all the lights synchronous flash on the scintillation effect to improve the navigation safety at night. Maritime buoys monitoring system designed in this paper, can timely monitor the running state of the buoys at sea, meanwhile, it can transmit the operation parameters of the mobile 3G network to the control center of the coast, when its running abnormal, monitor can use the computer terminal through 3G network communication system, send remote control monitoring instruction to monitoring unit of buoys to correct the abnormal problem, then make it running back to normal. Only when the buoy appearing larger displacement will be arrange professional to deal with. This system can greatly reduce the maintenance cost of buoys, has better value in use, especially applied in some of the South Chinese sea.

Design of Terminal for Telemetry and Remote Control

In the integration of telemetry and remote control navigation lights, as a component of the remote server communication on telemetry and remote control, the status of telemetry and remote control in system is quite important. While the function of terminal in the whole system is act as the middle layer between the control center and the data interactive on synchronous flash of the navigation lights. On one hand , our terminal receives the command from control center such as query parameter and query command, then analyzes the command function, and finally send the data commands to synchronous flash of the navigation lights by external communication interface board. On the another hand, On the other hand, the terminal the working state data and alarm data back from synchronous navigation lights by the special interface of external communication, then analyzing these data, using the corresponding format to encapsulate the results of the analysis as data packets protocol, through the wireless communication device sent the data packets to the remote service the database server and the TCP server, the processing program receive the data then analyze, classified and stored in the database of different data tables. Synchronization if belongs to the alarm information besides storing in a table, will immediately send the data to the monitoring host program control center, monitoring program will be display in Graphical visualization to the information.

Remote control terminal has another good function which is precise GPS positioning, can proofread current position of navigation lights in real-time. Suppose that the position of navigation lights drift by water flow, when more than set point value (50 m), the terminal will send alarm information to the server with initiative. In general, the positioning accuracy of remote terminal can reach 5M, when signal condition is good, the precision can reach 1M. Table1 lists the parameters on mainboard of our terminal. The physical character of connection was designed in Fig.1.

Tab.1 Parameter Setting on mainboard of remote control terminal

No.	Function Name	Default	Unit	No.	Function Name	Default	Unit
1	Location alarm switch	1		21	Range of work current of AIS buoys	0	MA
2	Location range	50	m	22	Voltage alarm switch of storage battery	1	
3	Collision range switch(option)	2		23	Upper range of voltage for storage battery	13	MV
4	Collision range(option)	0	level	24	Low range of voltage for storage battery	9	MV
5	Voltage alarm switch	1		25	The electric voltage alarm switch for generator(option)	2	
6	Upper range of voltage for navigation light	1300	MV	26	Low range of voltage alarm switch for generator(option)	0	MV
7	Low range of voltage for navigation light	900	MV	27	Oil level alarm switch for generator(option)	2	
8	Current alarm switch for navigation light	1		28	Low range of oil level alarm switch for generator(option)	0	percent
9	Upper range of current for navigation light	100	MA	29	City power outage alarm switch(option)	2	
10	Low range of current for navigation light	3000	MA	30	Interval of uploading data for terminal	60	min
11	Alarm switch of error quality of light	1		31	Buffer time of alarm for terminal	1	min
12	Alarm switch of light and lamp	1		32	Base point of latitude for terminal	0	′
13	Voltage alarm switch of radar response	1		33	Base point of longitude for terminal	0	′
14	Range of work voltage alarm switch of radar response	9000	MV	34	Work module of terminal	5	
15	Current alarm switch of radar response	1		35	IP address of server	0.0.0.0	
16	Range of work current alarm switch of radar response	100	MA	36	TCP transmit port	0	
17	code error alarm switch of Radar transponder in working time(Option)	2		37	No. of SMS(for mobile short message)	0	
18	Voltage alarm switch of AIS buoys	2		38	No. of light	0	
19	Range of work voltage of AIS buoys	0	MV	39	Threshold of light switch(option)	25	lx
20	Current alarm switch of AIS buoys	2	2	40	Cycle of light(one of 256 light quality)	1	

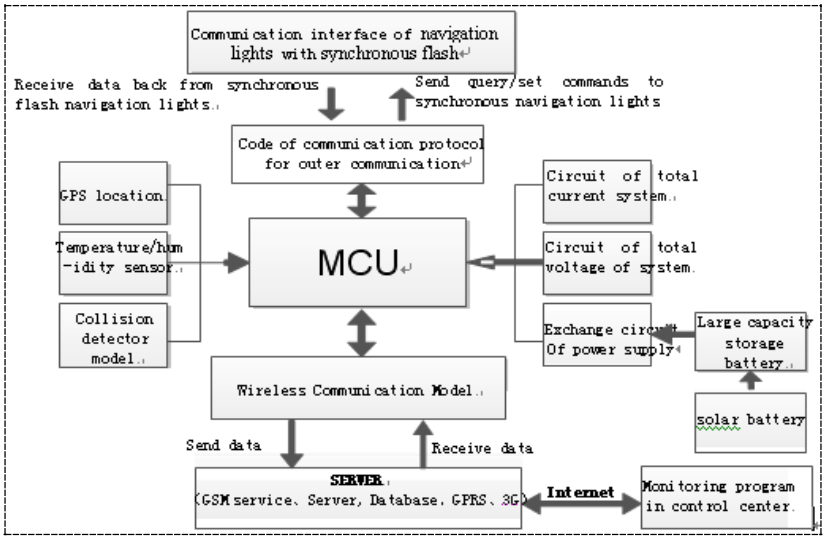

Fig. 1 Design of terminal for remote measure and control

From Fig.1 we can see, the terminal has 8 modules to perform data transmission and control through peripheral circuit. The detail description of each module is as following.

GPS module can provide the accuracy latitude and longitude data, in normal circumstances precision positioning can reach rang from 1-5M. Filtering algorithm and calibration was executed to the data back from GPS in our remote control terminal. Here the popular algorithm of Kalman as filtering algorithm was used, the algorithm is very suitable for the processing of GPS drift data correction. This data by remote real-time monitoring is the water out of the lamp offset range being allowed, if it exceeds the range value, it will send the alarm data to the control center.

Temperature/humidity sensor can collect information of navigation lights internal environment temperature/humidity, and transmit the data to the MCU of mainboard, MCU will upload the temperature data to the control center server, final display on the graphical interface of the monitor and control center, the staff in control center can determine radiation device of navigation light whether there is damage, then to decide the navigation light whether maintenance or not.

Collision detector module: This module uses three axis accelerometer as the main body, equipped with sophisticated software algorithms to compute whether the current navigation device impact by external. If the external collision happens, the module will send the level information to the MCU, based on this information, the module sends the data packet about collision warning to the control center.

Wireless communication module: Navigation light system working in the sea, so wireless communication technology must be used to address so long distance communication. The system provides a variety of communication channels, communication channels can be selected automatically according to the hardware assembly. Communication device support GPRS, 3G, GSM et al. short message service. Face so many means of communication, it is convenient to choose the actual situation of different sea area.

Power conversion circuit: The circuit of function is same as the circuit of navigation light synchronous flash.

Current acquisition module of the system: The module collects the discharge current of the battery in real-time, and transfer data to the remote MCU. MCU can judge the whole lamp is normal or not according to current value. If exceed the set range, MCU will take the initiative to send alarm data to the control center.

Voltage acquisition module of the system: The module collects voltage of battery in real-time, and transfer data to the remote control MCU, the MCU of motherboard can judge if the battery has been aging according to this value, if the value is more than the normal value, will send fault alarm data of the standard battery to the control center.

Solar energy charging circuit: The function of circuit is the same as the circuit of the navigation light flash. In the whole system, the terminal and synchronous flashing navigation light system is used with a solar charging circuit (integration here actually specify common using charging circuit and battery).

Server side of monitoring center

The main unit of remote monitoring of buoys is the monitoring center server side in the background, which provides the operation interface of human-computer interaction. Monitoring unit of buoys transmission the data to the background of the command and control center server, but also to receive the data and command which send from control center server, and according to the monitoring data of the command and control to navigation lights running. Design of framework on command and control center server is as shown in Fig. 2.

The server of monitoring and control center is a core component of the system on data processing and man-machine interaction. Through 3G, GPRS, Ethernet network receive the data from monitoring unit of buoys. After processing, the data can display in the terminal in form of a chart. When manager of the monitoring center found there have problems about the displaying data, you can enter commands to the server, monitor or control the display data. When the data exceeds the warning value, the alarm buzzer and the graphical interface display the alarm content in a way to manager of monitoring center.

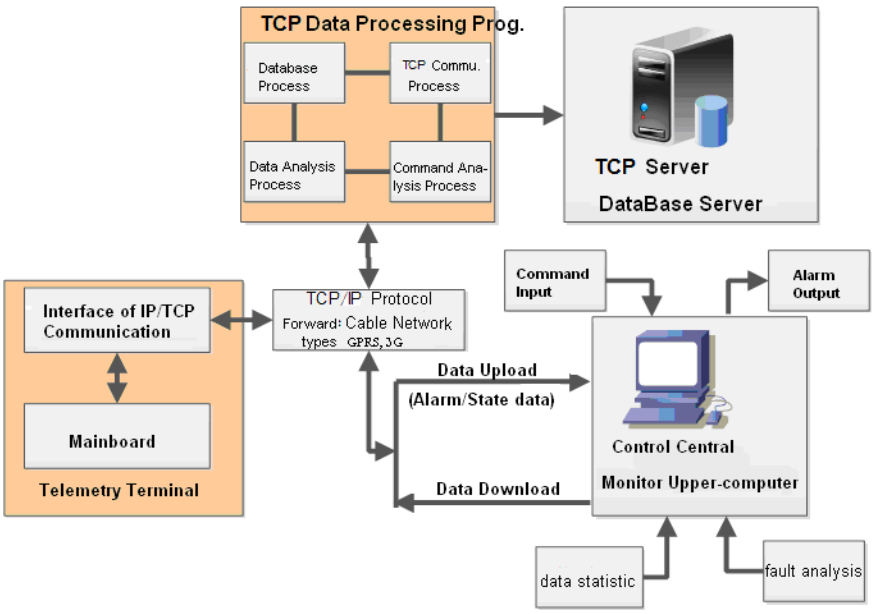

Fig.2 Framework of sever side in monitoring center

Integration of synchronous flash buoys monitoring system

Accordance to the above design ideas, using upper PC and lower machine serial programming, we perform the control procedures of monitoring unit of buoys, then burn the procedure into the chip. Programming language is assembly language, the software system in the server using VC++6.0. Figure 4-1, 4-2shows the interface of software system.

After starting the system into the buoys monitoring main interface, real-time data can viewed from all the navigation terminal, and the data update once every 10 seconds. Alarm information bar directly display the abnormal buoys, so you can quickly locate the fault of buoys terminals, and know what is the fault in first time.

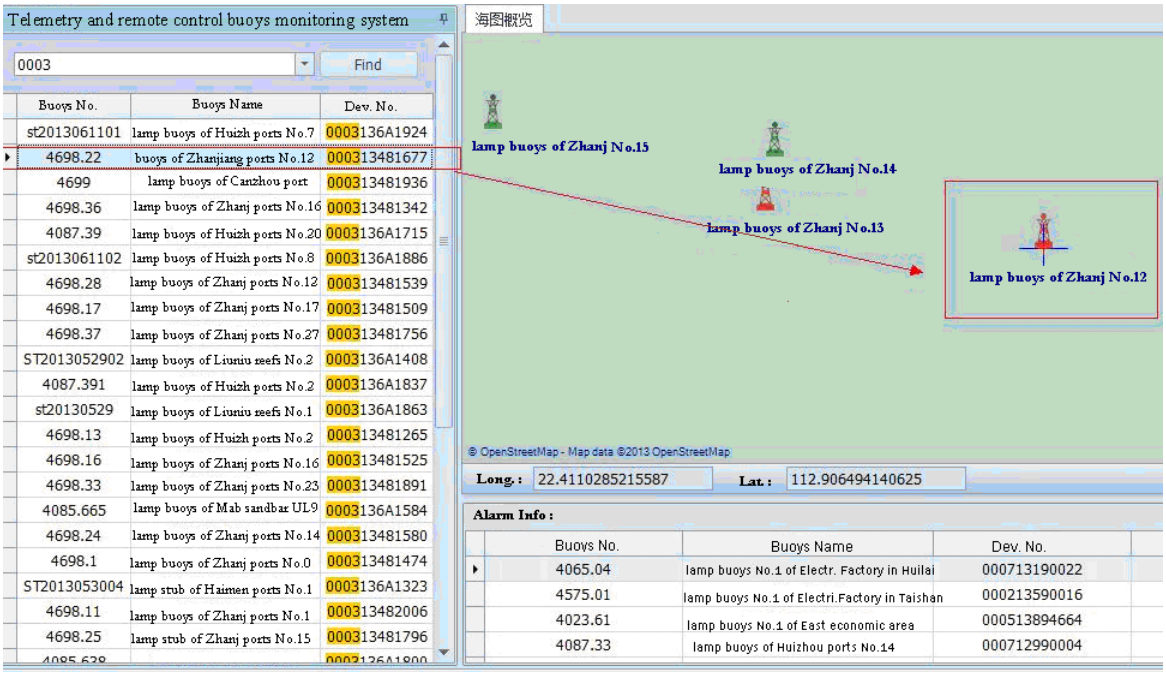

Fig.3 Interface of integration buoys monitoring system

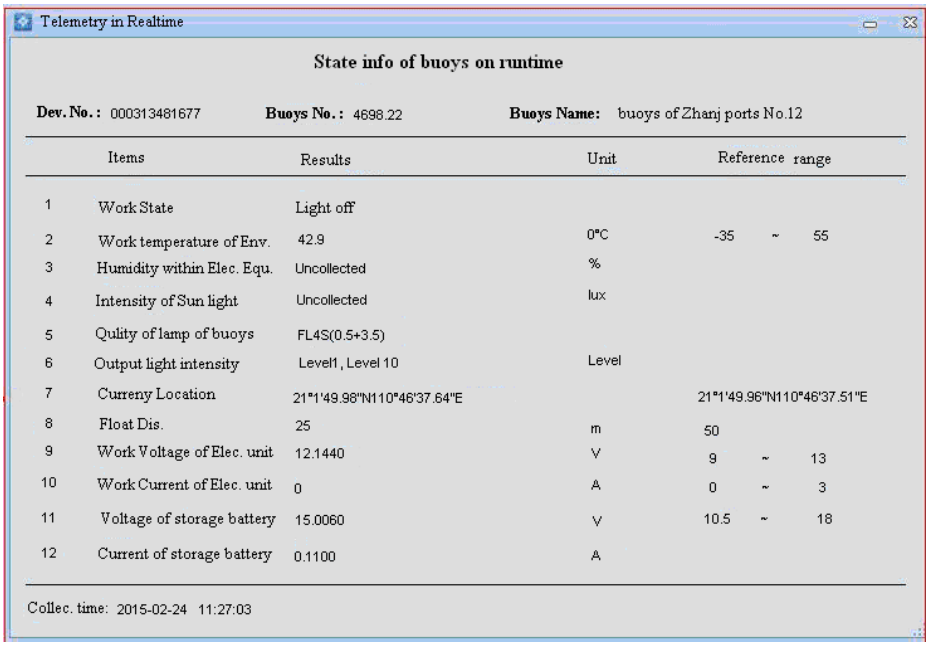

Fig.4 Data information of system detecting

When you click the remote control button, system will pop up the interface of parameter setting, the operator only need use the mouse to select the desired function, and enter the value you want to configure, you can submit the data and download terminal settings to the appropriate navigation lights. Interface of the device parameters are shown in Fig. 5.

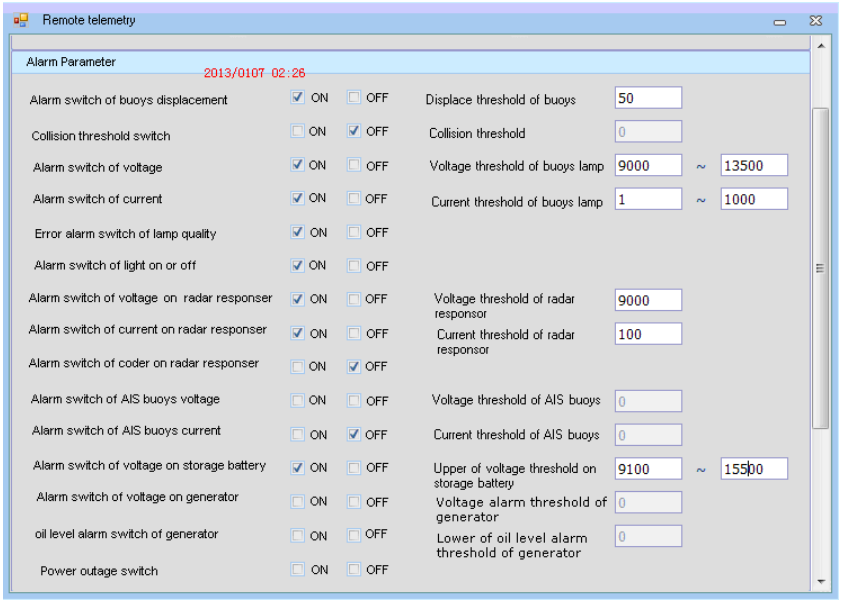

Fig.5 Interface of the buoys light parameters setting

Conclusion

New integrated buoys monitoring system using two level C / S (client / server) architecture, combined with modern wireless communication technology to realize remote real-time buoys light monitoring and control functions. Compared with the traditional buoys monitoring system, this system has the following characteristics:

First, the system uses C/S structure, easy to realize the management function. In this system, the first level C / S structure is reflected in: all the navigation lights in the sea area as the client, connect to a public TCP server with actively, the public server unified management all the Pharos of data storage, data analysis, alarm management and other functions, a set of parameters for forwarding, etc.

Second, the integrated navigation lamp system has rich parameter setting, and it's control function with powerful techniques in wireless communication can query and modify the working parameters, fault analysis by staff staying at home to achieve a full range of pharos real-time work state.

Third, equipped with a variety of wireless communication interface and management of AIDS to navigation station staff can be based on local signal, and cost estimating comprehensive evaluation, using one or a variety of means of communication. Communication interface is available: 1) GPRS network; 2) 3G network; 3) SMS communication system.

Fourth, integrated buoys monitoring system use a good real-time operating system, has tested successful with reliability characteristic. Also equipped with hardware monitoring and double watchdog technology, based on MCU on-chip watchdog and external professional watchdog chip, perform monitoring at the same time. Another, regardless which watch dog monitoring system software running abnormal, will be first time reset the MCU to use software system according to the normal orbit.

Fifth, the integrated buoys system is also equipped with a non-volatile memory, the working parameters of control center settings are permanent storage, all is not lose when reset system or the system is out of power.

Sixth, pharos lamp configured GPS positioning module, combined with the navigation system in assembly of micro backup battery, can achieve two functions: 1) real time monitoring pharos position. 2) anti-theft function: sometimes considered some unscrupulous fishermen may steal navigation lamp, to cut off the main power supply to the power.

Besides the advanced buoys system in previous stated. The system only uses a public server as all data storage and transfer station. When the number of lights is growing, the server load will become increasingly large, and the data volume will rapidly increase with multiply. If the configuration of the server hardware is not enough high, it can cause response abnormal for server system. Another problem is the work mode of one to many for the server, the operation capacity of server is very higher, otherwise there will be a query, slow control. Of course, the above two problems can be solved in currency science and technology.

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