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Application of wireless sensor network in ship control system

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1. Abstract

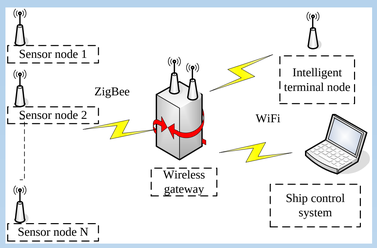
Ship control system needs a redundant network for security. In order to solve the problem of ship wired network, the paper designs wireless sensor network as redundant network of ship control system. A ship control system based on wireless sensor network is designed. The STM32F103 processor is the core of the wireless sensor network nodes, which runs on the Mindows real-time operating system, uses the coulombmeter method to monitor the battery level. In view of some problems in wireless network control system, the design of the ship course-keeping controller combines gray model with the robust PID control based on the algorithm of closed-loop gain shaping and takes compensation control of time delay and packet loss. The experimental results prove that the scheme is feasible and effective on network simulation platform. It is a beneficial attempt to apply wireless sensor network to ship control system.

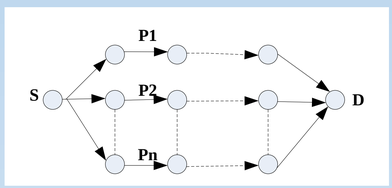
2. Introduction

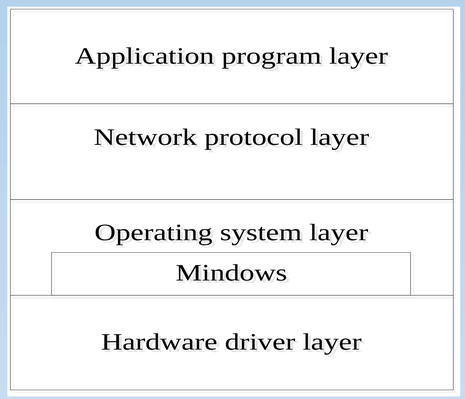
The ship wired network has some problems, such as the difficulties in ship wiring and fitting because of the confined space, high cost of wired cable, harsh conditions of engine room which made wired cable easily damaged. In order to solve the above problems, the wireless network is adopted to replace the wired network in the ship for it can not only achieve the on-demand deployment of a variety of intelligent terminals and sensors, but also solve the existed problems of the wired network. In contrast to the great restrictions of wired network to the mobility and flexibility of the new equipment, wireless network has better flexibility, which can achieve the on-demand deployment of a variety of intelligent terminals and sensors and effectively solve the difficulties in ship wiring and fitting because of the confined space in the ship.

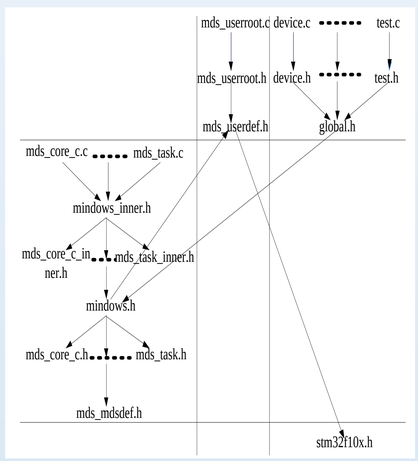
3. Overall design of ship wireless network control system

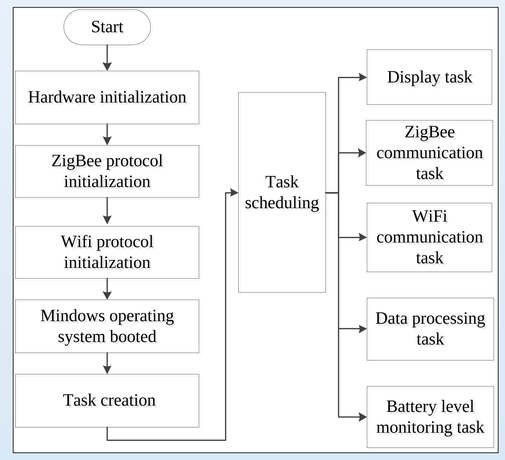
The system structure of the ship wireless wireless sensor network is shown in Fig.1. It includes wireless gateway, sensor nodes, intelligent terminal node, ZigBee wireless sensor network, WiFi network and ship control system. Different sensor nodes capture a variety of parameters of each main equipment (main engine, auxiliary engine, steering gear, etc.) in the ship engine room, such as temperature, pressure, rotating speed to ZigBee terminal node, which sends the data to the wireless gateway that is responsible for the conversion of ZigBee protocol with WiFi protocol through ZigBee wireless sensor network. The node devices within the ZigBee network can not only send the collected data to the ship control system but also communicate with node devices within the WiFi network through wireless gateway[5]. Besides, the wireless sensor network nodes can monitor battery level in real time and regularly send the data about battery level to the ship information system. When the battery level is low, the nodes prompts the user to charge the battery in time.











4. Simulation study

The ship model and controller are simulated and studied respectively in two upper computers. They communicate with each other through a hybrid network which is composed of Internet network and redundant ZigBee network. This study emphasizes the simulation of the control of the ship course-keeping based on wireless network control in redundant ZigBee network in case the Internet network cannot be connected.

When the simulation platform runs, the parameters about time delay and packet loss are firstly set in the network module. Then the communication is set in the ship model and controller module. Finally, the network connection is established. After that, the ship course is set and control algorithm is chosen in the controller interface. In the ship model interface, the ship model is selected, and the ship data is set. The experiments begin. The data is processed by algorithm model. The simulation curves of ship course and rudder angle are drawn in the ship model interface[6]

5. Conclusion

For the ships in which redundant control network needs to be installed, this paper proposed a scheme that wireless network can be used as redundant network, which can solve the problems of redundant wired network and possess the characteristics of flexible installation, low cost and powerful extensibility. The ship wireless sensor network was based on ZigBee and WiFi network. The Mindows embedded real-time operating system has been transplanted into the micro-controller STM32F103VCT6 of the nodes. The STC3100, a battery monitoring chip with the coulombmeter, was used to monitor the battery level in real time. The design of the ship course-keeping controller combines gray model with the robust PID control based on the algorithm of closed-loop gain shaping and takes compensation control of time delay and packet loss. The experimental results prove that the scheme is feasible and effective on network simulation platform. It is a beneficial attempt to apply the wireless sensor network to ship control system.