Design and Implementation of WIA-PA System Manager based on Embedded Platform

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Abstract. Aiming at the imperfection of systems management technology in the WIA-PA network, a design and implementation scheme of embedded platform based on WIA-PA system manager devices is proposed. The system selects ARM11 architecture based chip as the core controller, and it conducts data analysis and processing through the serial port system, which guarantees the real-time monitoring of network performance, and the configuration of network devices. Test results obtained by the self-built system demonstrate that the feasibility and rationality of the system manager device designed.

Keywords: Embedded, WIA-PA, system manager, Linux.

1. Introduction:

Industrial wireless technology is emerging in this century, it mainly faces short distance and low transmission rate between devices. Possessing the technical characters of low cost, anti-jamming capability, low power consumption, and real-time communication, it is the function extension and technical innovation of the existing wireless technology in industrial applications. Currently, industrial wireless technology gradually formed the three major international standards, namely WIA-PA standard, Wireless HART standard, and ISA100.11a standard. WIA-PA standard is self-developed and has international standards for intellectual property, which indicates that China has become a leading country in the field of industrial wireless research [1].

System manager serves as the core management unit of WIA-PA network, and it plays a very crucial role for the stability and reliability of the network operation. In the current WIA-PA network, system manager is mainly implemented on the PC (host computer) platform, then there is no portable system management devices [2], which causes great inconvenience for the network management and maintenance. In addition, the requirements of real-time performance, stability and accuracy of wireless communication in industrial automation are relatively high, which calls for efficient system management and comprehensive control of the network. Thus, design and implementation of WIA-PA system manager based on embedded platform is of great practical significance to promote the use of WIA-PA network.

2. The main design

2.1 WIA-PA standard Overview

As shown in Figure 1, WIA-PA protocol uses a two layer network topology: Mesh (mesh) and Star (Star) [3].

To facilitate management functions, WIA-PA standard defines five types of logical roles [4]: Gateway, network manager (NM), security manager(SM), cluster head, cluster members.

Gateway is responsible for protocol conversion and data mapping between WIA-PA network and other networks that exist in the real network environment.

Network manager (NM) is responsible for the management and operational performance monitoring of the whole network.

Security manager(SM) is responsible for WIA-PA network key management and secure authentication of all devices except for the host computers;

Cluster head is responsible for safe aggregation and forwarding data between cluster members and other cluster-heads, meanwhile monitoring and managing the operation status of the star network, which is composed of field devices and handheld devices (if any).

Cluster members are responsible for obtaining field data, and sending them to the cluster head.

In the two-tier topology of the star and mesh combination of WIA-PA industrial wireless network, system management device and the gateway device communicates with each other through the serial port or wireless data transceiver module. Through the handheld system management device, the regulator can monitor network performance and configure network device anytime and anywhere. WIA-PA interconnects with other networks via gateways.
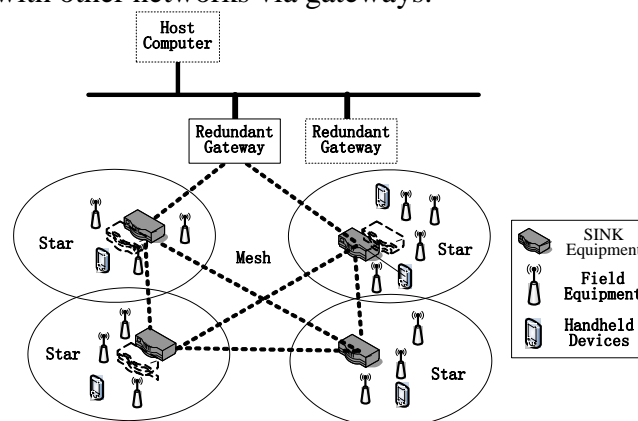

Fig.1 WIA-PA Network Structure

2.2 Core Design

System management of WIA-PA network mainly includes network management, communication resource allocation, routing configuration, monitoring network status, control and management of information. Based on the function of WIA-PA system manager devices in the WIA-PA network and the requirements of handiness, intuitive interfaces, energy saving and so on, this paper proposes a scheme to make a stand-alone device which integrates network management functions and friendly design of interactive interface.

Industrial wireless WIA-PA system manager device includes hardware and software components. According to the actual situation, future development of the field, and the latest developments in microprocessor technology, this paper proposes a feasible approach to meet the design requirements. The overall design scheme is shown in Figure 2.
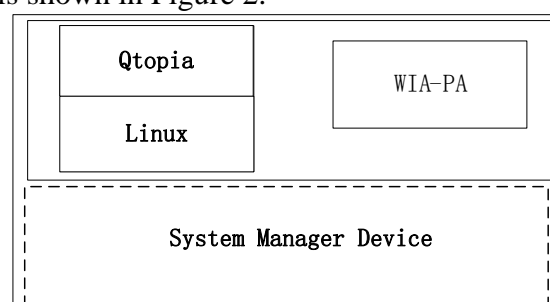

Fig.2Overall design of industrial wireless WIA-PA system manager device

2.3 Software Design

The software part of industrial wireless WIA-PA network systems manager includes the Linux operating system and system management software. Linux operating system provides device management software system, file management, process management, storage management, and other services. QT interface system is a cross-platform graphical user interface library, system management software is based on user's demand in QT interface required for the design, and equipment design application is responsible for monitoring equipment operating status and other functions. Industrial Wireless WIA-PA System Manager appliance software program shows in Figure 3.

To realize the system management functions on this platform, the required modules are as follows: a communication module, which is used to receive and transmit data packet of gateway, passing the

received data to an afterward data processing threads; network performance monitoring module, which visually displays and analyses network data packets received at present[5]; network management module manages WIA-PA network device properties and communication, networking process-related properties; security module manages WIA-PA network security-related equipment properties, such as network authentication devices, distributing keys and so on.
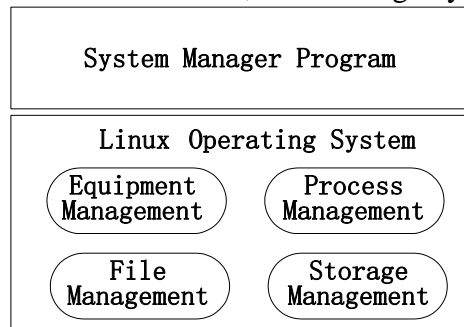

Fig.3 Solutions of industrial wireless WIA-PA system manager device software

2.4 Hardware Design

The hardware part of industrial wireless WIA-PA system manager device is composed of the master controller, display module, data transmission module, power supply module. The main controller is responsible for processing the data coming from the transport module, and it makes the appropriate judgment under different circumstances; data transmission module is responsible for receiving data and sending commands to the gateway device, to realize the communication between host controller and the gateway device; display module displays the operation status of the WIA-PA network and provides visual management interfaces; power supply module provides energy for the normal operation of the system manager devices.

SAMSUNG's main controller system is based on ARM1176 16/32 RSIC's low-power, high-performance general-purpose microprocessor, which has media processing capabilities, low power consumption, and rich peripheral resources, and it can realize the network, serial communications, LCD and many other features, and can be ported Linux operating system, it is easy to solve some complex low-power system design problems.

The overall system manager device hardware system block diagram is shown in Figure 4.
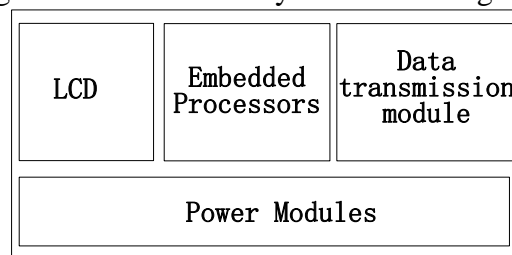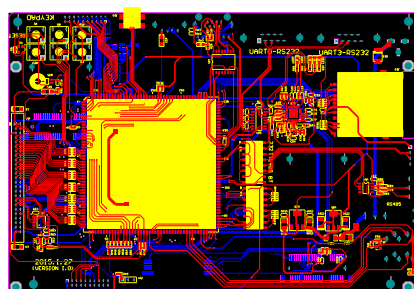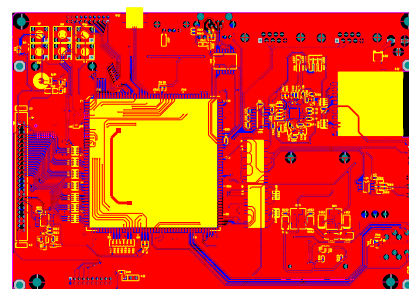

Fig.4 The Overall Hardware Block Diagram of System Design Manager Device

3. Design and Implementation of The PCB

PCB Layout   PCB Design is Complete Map

Fig. 5 PCB Design

Layout is a very important part and it will affect the success of the wiring, causing significant impact on the final circuit board signal integrity. In the actual circuit board design process, developers

need to consider the problem of interference and wiring reasonability, to conduct rational layout of various functional units and keep a distance between traces to reduce signal crosstalk between the lines. According to the principles of layout and routing requirements, PCB routing results are shown in Figure 5.

4. Testing and Verification

After entering linux system with touch calibration, the running user interface of QT application is shown in Figure 6. This indicates the LCD touch screen works, and related hardware circuit design is successful.

Fig. 6 Enter Linux System   Fig. 7 Physical Test

Functional verification system is a hardware device which is an essential part of the development process used for verifying the function realization and stability. Because the system manager software part is in the final development stage, this time in the development of the device program only Linux operating system to load QT interface. In the laboratory environment, the equipment operation effect is good, LCD displays properly, and touch control also works well, as shown in Figure 10.

5. Conclusion

Aiming at the oneness, inconvenient operation and other issues of current systems management device of industrial wireless WIA-PA network, this paper, firstly describes the background and research status of industrial development of wireless technology. And then designs and achieves a WIA-PA system manager devices based on embedded platforms according to WIA-PA standard technical requirements. System hardware selects Samsung's S3C6410 as the control core the display module with 7 inch and four-wire resistive touch screen control, including standard serial peripheral interface, Ethernet port, WIFI, buttons, USB, SD card port, power supply with 5V/2A DC input, an optional adapter or lithium battery-powered; as the system software to the Linux platform, through the serial port system collected data analysis and processing, real-time monitoring of network performance, configure network devices. The test results obtained demonstrate that the design of the system manager devices is practical and reliable.

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