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Application of Wireless Sensor Network to Automatic Water Supply Scheduling System

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Abstract

The automatic water supply scheduling system based on SCADA and GIS has been designed, which takes the technology of wireless sensor network to realize the RTU module and the wireless transmission of the monitored data. It has strikingly improved the flexibility of the system arrangement and cut down the running cost of the monitoring system. The online operation of this system will offer in-time comprehensive information of the water supply networks, realize an overall management and analysis of the data system, promote the information management level of the water supply enterprise, and intensify the core competence for the enterprise.

Key words：WSN；SCADA；RTU

INTRODUCTION

U RBAN water supply is fundamental to the stability and development of the city, which functions as the lifeline in the urban development. With the economic development and urban expansion, the traditional water supply management is under great pressure, unable to react promptly to the changeable situation. The automatic water supply scheduling system takes the technology of wireless sensor network, communications and the automatic control to monitor the major specifications, pipeline networks and facility operation, thus realizing the overall management of water distribution networks. The system can realize real-time scheduling and automatic information management, combine the measured points and network space position, illustrate the network operation intuitively with the help of graphics. According to economic and technical index, it can also optimize the control feedback, combined with prediction, statistics, mathematical model, spatial analysis, etc., fufilling reasonable water supply distribution in all stages[1].

Collecting real-time specifications in the water supply network operation is the key to the water supply scheduling system, resulting in adequate actions accordingly. The existing ways of data transfer, like fixing private circuitries, data radio station, GSM, GPRS, etc. fail to solve the defects of long-time construction, easy disturbance and high-cost operation. But the wide application of WSN Zigbee provides a new way to design the data transfer for automatic water supply scheduling system.

Brief introduction to Zigbee

Zigbee, standardized on IEEE802.15.4, is the two-way wireless communication technology, low complex, low cost, low power and slow rate. It is featured as follows: 1) low consumption: take JENNIC5139 for example, data is transferred with low power waste less than 120mW; 2) less investment: Zigbee is free on 2.4GHz ISM frequency band; 3) high network capacity: one network based on Zigbee can hold at least 65535 nodes; and 4) high data security: it supports AES128 algorithm encryption to enhance the data security[2].

Zigbee network supports 3 kinds of network topology structures: star topology, mesh topology and clustered topology. So, in the long-distance transmission can be conducted , only if we increase

routing nodes. Communications network is fast at up to 250Kbps, which can completely meet the demand of data monitor required by automatic water supply scheduling system.

System compostition

A water supply company consists of many subordnate water plants, which takes charge of multi-tasks and several network pressure measurement stations, pressurization station and water sources wells. It is not reasonable for the company to monitor all the systems, if all the information is sent to the control center. So several branch water supply centers are required, with some monitoring stations and water-fetch & water-supply stations in them, to realize gradual- transferred information and graded – control. Learning from people at home and abord, water supply scheduling system adopts two-step scheduling. The model is shown in Fig 1[3-5].

The system consists of five components: control center of the water supply company, the branch control center, pressure measurement station, pressurization station and water sources well monitor stations. As a baisc part, RTU is conducted by WSN, which collects and transfers real-time data and controls the on-site facilities.

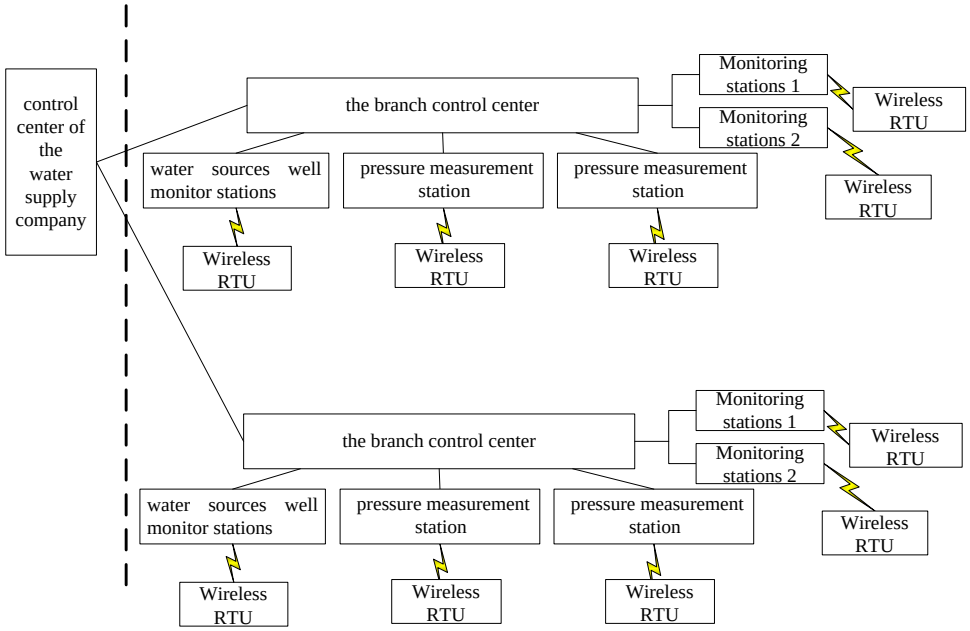

Fig.1. Model for automatic water supply scheduling system

The water supply scheduling system based on SCADA and GIS can realize integrative management for water supply information management and dispatching supervision. It includes some models, i.e. data management, inquiry statistics， pipeline network edition, scheme simulation, fault section diagnosis, network reliability management, facility management and aging calculation.

Data management: It stores the graphic data(vector and raster) and non- graphic data(pictures, file, multi-media) in the relational database.

Inquiry statistics: It provides some methods to inquire graph, attribute data, count the range of clusters number and classifications required by the user accordingly, analyze pictures' number, maximum, minimum and average. The above can be illustrated by histogram, piechart, line graph, etc.

Pipeline network editing: The system provides perfect editing tools, with which uses can add, modify, delete the pipeline network space and attribute data. While editing, the perfect facility rule database to ensure the edited data to be correct and complete, and to support version management and long transaction processing.

Scheme simulation: Before the water supply scheme is put into practice, the system can simulate water flow distribution from SCADA operation parameters. It can also check waterflow by waterpipe diameter, that is, if the warer pressure is beyond limit, it will alert and avoid pipe

breakage.

Fault section diagnosis: When water supply is cut off, it can find out the user's water supply information and valve position on the map. Then the valve is shown to find the fault point and help isolate fault-pipes, announce water stopping news. When the valve is powered off, the line color controled by the vavle on the user interface map will change from red to black and list all the users with the same problem. The dispatcher can report the water interruption area and the users' names to TV station and pager station.

Network reliability management: In the system, each pumping station, valve and waterline are connected with users. Therefore, the system, depending on its operation can decide whether to stop the pumping station, open or close valve, decide the water-stopping area and list the users'names automatically. And from the change time, it will decide the water-stopping time and uses' numbers.

Facility management: It manages the facility repairing, rebuilding and expansion, facility operation of the pipe network, including managing patrol, listening inspection, repairing, maintenance work, water-stopping, etc, and assess facility quality and the repair workers's assessment.

Aging calculation: The system can analyze the model, know about the urgency level for the pipeline and calculate the work time needed, judging from the pipeline material, embedment environment, fixed number of years, repair frequency, etc.

RTU realization

RTU, an important part of the automatic water supply scheduling system, monitors local data collection and transfer, receives and fulfills remote control orders, thus realizing the local control. To reduce deployment costs and operation costs, RTU adopts JENNIC-5139, with main equipments: CPU, analog I/O, communications, power supply, communications facility, computer case, measuring device and physical execute machine. The construction is shown as Fig2.

CPU model includes JENNIC-5139, operating voltage 3V, working current 37mA, sleep-model electrical current 2.6μA, embeded Zigbee wireless communication protocol. It supports wireless sensor network communication, takes the 32-bit arm risc cpu, internalizes 96KB RAM, 192KB ROM, four 12-bit ADC and convert output water pressure, output water quantity, water level,

distribution voltage analog into digital numbers. Voltage sensor system can measure system electrical pressure, while temperature sensor can measure environmental temperatures. Temperatures can be used to make up the measuring specifications, improving measurement accuracy. Two UART can make CAN interface, and JENNIC-5139 is powerful to expand easily. There are two kinds of power supply modes: battery-power and external power. Without external power, the battery-power is put into use; but with it, it works and charges the battery immediately.

Conclusion

The automatic WSN water supply modeling system uses Zigbee technology to use SCADA to extreme extent. Water quality and water pressure is prerequisite for reducing running costs and appropriate water supply distribution. And the flexible monitored RTU provides real-time data for the WAN modeling system. GIS system can make the data measured by RTU spatial and three-dimentional, making the real-time measurement data visualized. Compared with the traditional data radio, WSN can improve the data reliability and security. The operation costs are greatly reduced than GPRS data transmission, featured as low investment, short construction, simple maintenance, low price, and so on.

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References

[1] HUI Nan-mu,LI Yong-gang,"Wireless Farmland Measurement and Control System Based on Zigbee,"*Microcomputer Information*, 2008,24(8-3):52~54

[2] LI Hui,ZHANG Xiao-guang,GAO Ding,SUN Zheng, "Application of WSN Based on Zigbee in Mine Safety Monitoring ,"*Instrument Technique and Sensor*,2008,(4):33~35

[3] SONG Jun-jie, YIN Zhi-hong, "Remote Monitoring System for Water Supply Dispatching Based on Wireless Communication,"*CD Technology* , 2006,(5):18~20

[4] JIA Jin-ming,LI Xue-yi,CHEN Xue-jian, "Upgrade and Renovation of SCADA System for Supply Water Dispatching,"*China Water & Wastewater*,200824(12):66~68

[5] GUO Sheng-an,"Urban Water Supply SCADA System's Change and Development ,"*Industrial Control Computer*,2009,22(4):29~30

[6] LIU Qing-lin,"The application of SCADA system in the water supply of city ,"*Computer and Information Technology*, 2003, 11 (6):50~353.