

Research on Library environmental monitoring system based on ZigBee Network

Run Gao ^a, Lizhen Zhang ^{b, *}, Bo Jiang ^c and Peng Wang ^d

College of Engineering, Shanghai Ocean University, Shanghai 201306, China

^argao1990@126.com, ^blzzhang@shou.edu.cn, ^cbjiang@shou.edu.cn

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Abstract. According to the special needs of temperature, humidity, illumination and other environmental parameters monitoring in university library, proposed ZigBee + GPRS mode of communication based on ZigBeePro2007 wireless networking protocol, through the design of hardware and software, real-time monitoring system of library environment parameters was constructed. And realize the field monitoring of Shanghai Ocean University Library environmental. Monitoring results show that the system can better apply to the University Library, to reach monitoring purposes.

Introduction

University Library as one of the three pillars of the school in the 21st century, bear the important mission to save rare books and documents provided for students to learn and read. Many factors affect the save of library books, which environmental factors (temperature, humidity, illumination, etc.) is the most important. For the library collection, the optimum temperature for the indoor is 18 ~ 22 °C, the optimum relative humidity is between 60% to 65% ^[1]. General basic stacks of illuminance are appropriate 30 to 50Lux, reading illumination are appropriate to 75 ~ 100Lux ^[2].

Due to large number of people in university library, indoor environmental quality directly affects the efficiency of teachers and students to learn and health of physical and psychological. Environmental psychology research confirms that a variety of factors that intellectual activity of the human brain and the environment have a great relationship ^[3]. Reader's activity at the library, proper ambient light intensity and the light is too strong or too weak will affect the thinking and judgment, suitable temperature is also an important factor in the library environment. Therefore, the establishment of an environmental monitoring system in the library, capable of real-time monitoring of the indoor temperature, humidity and light intensity and other environmental data, and can be a demand for intelligent feedback according to the set threshold.

Indoor Environment Monitoring Network System Introduction

The traditional library environment mostly manually collected data, including digital hygrometer, illumination instrument. Abroad as early as the 1970s began to study the temperature and humidity control technology, which uses a combination of analog instrumentation, acquisition of temperature and humidity information and instructions, recording and control, but the accuracy and consistency of data is not guaranteed. Based on RS485 cable detection techniques require a large amount of laying transmission lines and equipment for centralized power in the economy and flexibility, there are some problems ^[4]. Existing techniques to monitor the indoor environment is to be automated, unmanned direction, and wireless sensor networks (Wireless Sensor Network) are equipped with these features. Wireless sensor networks are deployed in the area to monitor a large number of cheap micro-sensor nodes through wireless communication to form a multi-hop ad hoc networks ^[5]. Common wireless communication protocol specifications are summarized in Table 1.

ZigBee technology is a wireless transmission technology agreement with a close, low complexity, low power, low-rate, short-latency, high network capacity, low cost, reliable, safety features, mainly used for short distance, data transfer between low-power and the transmission rate is not high, and a variety of electronic devices typically have periodic data, intermittent data and low latency data

transfer applications [6]. Therefore, the use of the characteristics of ZigBee technology, combined with the special needs of the University Library environmental monitoring, offered to ZigBee + GPRS technology, monitoring programs, both from the hardware and software design completed university library environment monitoring system.

Table.1 the technical specifications of several wireless communication protocol

	Bluetooth	ZigBee	Wi-Fi	Infrared
Range	10m	100m	1m	75m
Rate	1Mbps	11-600Mbps	3Mbps	2503Mbps
Band	2.4GHz	2.4Hz,5MHz	980nm	869/915MHz 2.4GHz
Standard	802.15.1	802.11	Not uniform	802.15.4
Power	High	Higher	Lower	Low
Costs	General	High	Low	Low

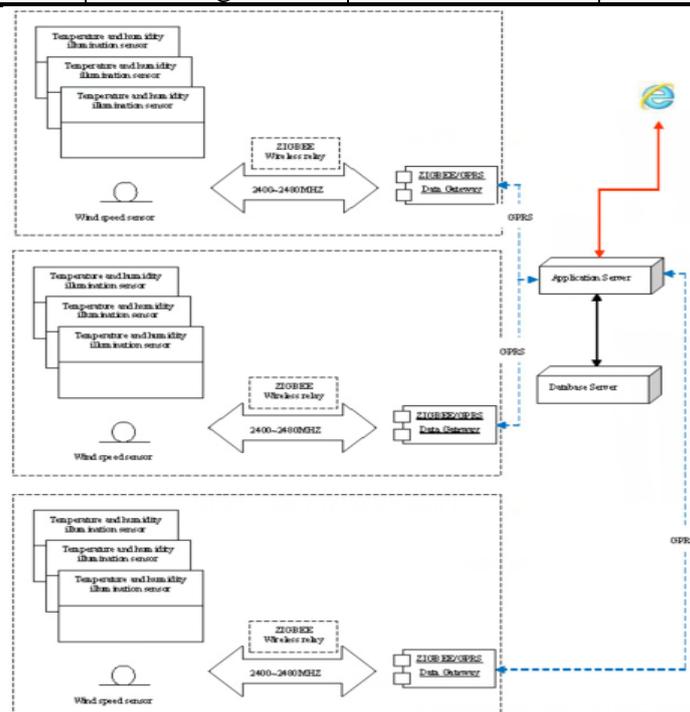


Fig.1 Network topology graph of monitoring system

Monitoring System Design

Academic Library Environment Monitoring System main function is to achieve long-term and efficient on-line monitoring and transport-related environmental parameters. Making the overall program design, first needs to consider the environmental characteristics of the University Library, monitoring point layout and construction of the network system and other factors to determine monitoring parameters, hardware selection and transport protocol settings, etc., combined with various hardware modules and transmission protocols the set design software monitoring section.

This system of Shanghai Ocean University Information Center as an experimental system design environment, based on ZigBee + GPRS network, the device layer by high-precision temperature, humidity, illumination triple wireless sensor composed, ZigBee / GPRS data control layer gateways and user-level layer structure on the IAR Embedded Workbench 8051 developed, whose network topology structure shown in Figure 1.

Monitoring system hardware design

Monitoring system hardware design includes composition and network coordinator node monitoring sites designed [7]. The functional requirements of the system, the architecture shown in Figure 2 involves

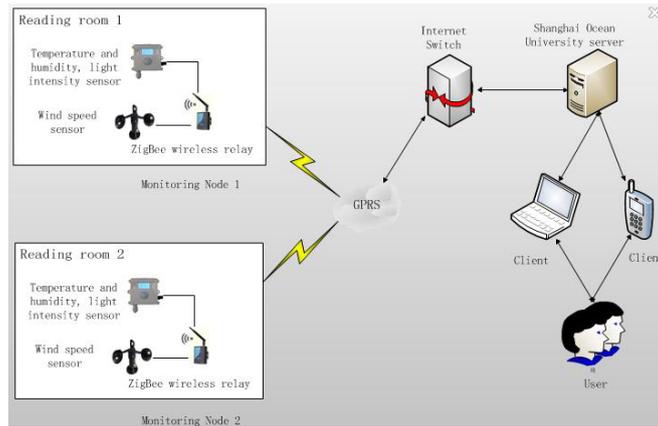


Fig2. The structure of library environment monitoring system

Library based on ZigBee technology monitoring system

Shown in Figure 3, this experiment chose Shanghai Ocean University Information Center on the first floor and second floor reading room, because the light intensity is stronger, larger space, the number of frequent access, is not conducive to wiring, requiring the use of wireless communication protocols transmission signal. The nodes in the network are arranged in a suitable location in the reading room, all nodes are hung module temperature and humidity, light intensity, such as sensors, near the sunny side of the window to form a numerical comparison also hung sensor. 1min collected once every terminal node data, the length of time interval can also be prepared in accordance with the needs of the administrator, as shown in Figure 4.

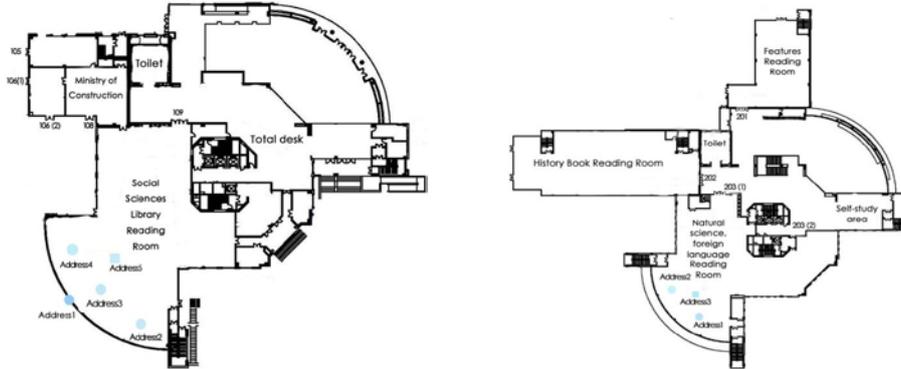


Fig.3 Plane graph of the library reading room

At the same time, through the ZigBee wireless sensor network and GPRS technologies, when collecting data once over the threshold, the system will automatically alarm. ZigBee wireless sensor networks can also be combined with automatic control technology, depending on the circumstances, the automatic control system to adjust the temperature of the air conditioning and curtains opening and closing, etc., to improve the efficiency of the staff of the university library, the ambient temperature to maintain optimal library.

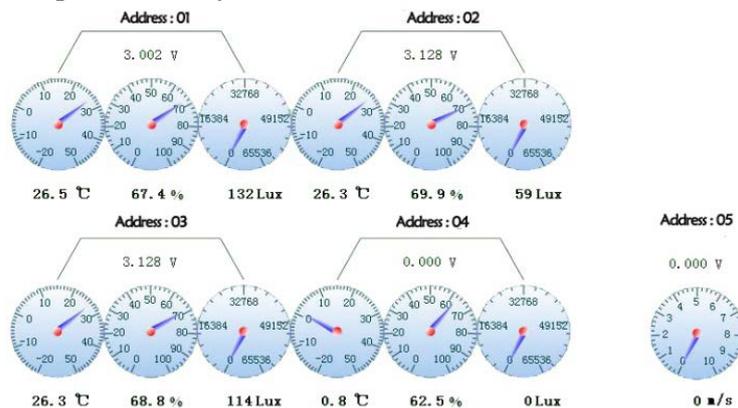


Fig.4 Interface of the library real-time monitoring platform

Figure 5 shows the experimental part of the monitoring data, the library can be seen between the air temperature is maintained at 27 ~ 27.5 °C, relative humidity is maintained at between 61.5 ~ 64.3%, light intensity between 348 ~ 901, the Library high temperature, humidity and light intensity overall value, not the best reading environment should be improved.

Conclusions

Based on the special environmental requirements Shanghai Ocean University Library and Information Center, designed a wireless remote environmental monitoring system, according to the particularity of the university library and interference environment as well as the selection of the sensing device to determine the coordination ZigBee + GPRS network protocols . System from the beginning of July 2014 at Shanghai Ocean University Information Center conducted experiments including environmental test data acquisition, monitoring software recording and alarm testing. After field tests show that the system is stable and reliable application for promotion in academic libraries, in terms of field data acquisition to lay a good foundation.

Date Time	Temp 1	Hum 1	Illum 1	Temp 2	Hum 2	Illum 2	Temp 3	Hum 3	Illum 3	Temp 4	Hum 4	Illum 4	Wind velocity
21 2014-09-17 11:43:04	27.2	63.8	348	27.2	61.5	610	27	63.7	506	26.8	62.8	513	0.1
22 2014-09-17 11:42:04	27.2	63.8	348	27.2	61.5	610	27	63.7	546	26.8	62.8	513	0.1
23 2014-09-17 11:41:04	27.2	63.8	348	27.2	61.5	610	27	63.7	546	26.9	62.8	512	0.1
24 2014-09-17 11:40:04	27.2	63.8	348	27.2	61.5	610	27	63.7	546	26.9	62.8	512	0.2
25 2014-09-17 11:39:04	27.2	63.8	348	27.2	61.5	818	27.1	63.7	540	26.9	62.8	512	0.2
26 2014-09-17 11:38:04	27.2	63.8	348	27.2	61.5	818	27.1	63.7	540	26.9	63.4	512	0.2
27 2014-09-17 11:37:04	27.2	63.8	348	27.2	61.5	818	27.1	63.7	540	27	63.4	516	0
28 2014-09-17 11:36:04	27.2	63.8	348	27.4	61.5	661	27.1	63.7	540	27	63.4	516	0
29 2014-09-17 11:35:04	27.2	63.8	348	27.4	61.5	661	27.2	63.7	482	27	63.6	516	0
30 2014-09-17 11:34:04	27.2	62.5	901	27.4	61.5	661	27.2	63.7	482	27.1	63.6	511	0
31 2014-09-17 11:33:04	27.2	62.5	901	27.4	61.5	661	27.2	63.7	482	27.1	63.6	511	0
32 2014-09-17 11:32:04	27.2	62.5	901	27.4	61.8	748	27.2	63.9	578	27.1	63.6	511	0
33 2014-09-17 11:31:04	27.2	62.5	901	27.4	61.8	748	27.2	63.9	578	27.1	63.9	511	0
34 2014-09-17 11:30:04	27.2	62.5	901	27.4	61.8	748	27.2	63.9	578	27.3	63.9	599	0
35 2014-09-17 11:29:04	27.2	62.6	879	27.4	61.8	748	27.2	63.9	578	27.3	63.9	599	0
36 2014-09-17 11:28:04	27.2	62.6	879	27.5	62.1	750	27.3	64	554	27.3	65	599	0
37 2014-09-17 11:27:04	27.2	62.6	879	27.5	62.1	750	27.3	64	554	27.4	65	580	0
38 2014-09-17 11:26:04	27.1	62.6	847	27.5	62.1	750	27.3	64	554	27.4	65	580	0
39 2014-09-17 11:25:04	27.1	62.6	847	27.6	62.9	682	27.3	64	554	27.4	65	580	0
40 2014-09-17 11:24:04	27.1	62.6	847	27.6	62.9	682	27.5	64.3	495	27.4	68	580	0
41 2014-09-17 11:23:04	27.1	62.6	847	27.6	62.9	682	27.5	64.3	495	27.3	68	593	0
42 2014-09-17 11:22:04	27.1	62.9	876	27.6	62.9	682	27.5	64.3	495	27.3	68	593	0

Fig.5Interface of the library monitoring alarm

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