



Research Article

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Application of ZigBee wireless sensor network and GPRS in development of intelligent logistics system

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ABSTRACT

In this paper, the design of wireless sensor node is serial communication module with IEEE/ZigBee transmission module to replace the traditional, logistics collected data will be wirelessly sent. The GPRS communication circuit is mainly composed of a power supply circuit, GPRS module, SIM interface circuit and the serial interface circuit part. Its core is the GPRS module. The paper presents application of ZigBee wireless sensor network and GPRS in development of intelligent logistics system. Intelligent logistics system can solve the real-time information acquisition and logistics operation by ITS and related information technology, and carries on the collection of information in an integrated environment analysis and processing.

Keywords: Wireless sensor network, Intelligent logistics system (ILS), GPRS, ZigBee.

INTRODUCTION

Intelligent logistics system (ILS) in the intelligent transportation system (ITS) basis and related information technology, electronic commerce (EC) of modern logistics service system operation. It solves the real-time information acquisition and logistics operation by ITS and related information technology, and in an integrated environment for the acquisition of information analysis and processing, through the information transmission in each link in the logistics, to provide detailed information and advisory services for the logistics service providers and customers.

Under the new logistics system, when we put the intelligent logistics distribution center back network system of intelligent distribution network, visual management, fully automated integrated logistics information platform, produced wisdom. At present, in the Internet of things the first part of the province has started to explore the construction of the logistics information platform of the Internet of things [1]. Public logistics information platform to the theory of modern logistics and supply chain management theory as a guide, in accordance with the "planning principles of resource reuse, information sharing, easy management, improve efficiency, uniform standard", in order to improve the public information capacity and level of service as the focus.

Wireless sensor nodes are generally consists of a sensor module, data processing module, data transmission module and power management module is composed of four parts. Among them, the sensor module is responsible for collecting the monitored area information and complete the data conversion, acquisition of information can include temperature, humidity, light intensity, acceleration and atmospheric pressure; data processing module is responsible for the control of the node processing operation, routing protocol, synchronous positioning, power management and task management; data transmission module for wireless communication and the other nodes or Sink node, exchange control messages and send and receive data acquisition; power management module through the use of sensor node power supply, using micro batteries, to reduce the volume of section point.

High speed transmission of GPRS data transmission speed of up to 57.6KB/s, the maximum can reach

115-117.2kb/s, and can fully meet the application requirements. Short access time GPRS access waiting time is short, can quickly establish a connection, the average is 2s. To provide real-time online user will initially in the line and the online status, which will enable the access service becomes very simple, fast. Support IP protocol and X.25 protocol GPRS support the most widely used on the Internet IP protocol and X.25 protocol, and the GSM network coverage, global wireless access enables GPRS to provide Internet and other packet network, from the GPRS features of the above can be seen, the real-time transmission of GPRS network is especially suitable for frequent small amount of data.

Intelligent logistics is based on the height of the development of modern information technology, the use of advanced information collection, information processing, information flow and information management technology, including the completion of basic transportation, warehousing, distribution, packaging, handling and other activities of the goods from the suppliers to those in need throughout the process of moving, provide maximum profits for the supplier. The paper presents application of ZigBee wireless sensor network and GPRS in development of intelligent logistics system.

2. Using ZigBee Wireless Sensor Network in Building Intelligent Logistics System

Wisdom embodied in: logistics to realize intelligent monitoring, active monitoring vehicle and goods, the active analysis, access to information, realize the whole monitoring process; intelligent transfer external data within the enterprise, integrated, flexible, through the realization of the entire supply chain EDI technology; intelligent logistics decision making, data monitoring, by contrast analysis of the real-time, continuous optimization of logistics process and scheduling, timely response to customer demand for personalized; based on a large amount of basic data and intelligent analysis, modeling and simulation, realize the logistics strategic planning prediction, to ensure the accuracy and scientific of the future logistics strategy.

IEEE802 series standard to the data link layer is divided into the medium access layer of MAC and logical link control layer of LLC [2]. IEEE802.15.4 MAC sub layer supports a variety of LLC standard. Data frame transmission equipment between the services of the MAC sub layer physical layer provides the implementation; and LLC sub layer based on MAC sub layer, to the equipment to provide connection oriented and connectionless service. The MAC sub layer includes: coordinator from concurrent a beacon frame, common equipment according to the beacon coordinator of frame synchronization and coordination unit; association supports the PAN network and cancel conjunction; secure communication support wireless channel; CSMA-CA mechanism; support the protection time slot (GTS) mechanism; reliable transmission between the MAC layer supports different equipment the. The LLC sub layer function includes: the transmission reliability assurance and control; data segmentation and reassembly package; sequential transmission of a packet.

In wireless sensor networks, node randomly scattered in the monitored area. Nodes in ad hoc forms by multi hop relay network, the monitoring data to the Sink node, the final with a long Sink link distance or temporary build the regional data to the remote center for centralized treatment.

Intelligent warehouse management system integrated library, library, storage and custody of the real-time and historical data, data warehouse, data mining process and create an environment for online analysis, which helps to find the deep information and knowledge from data, the non hidden intuitive, information and knowledge with the intuitive description form, aided decision-making. The logistics business to customer demands more quickly, and it can achieve the dynamic management of goods into the library and storage capacity, accelerate inventory turnover rate, reduce inventory, improve efficiency.

Sensor network (WSN) change rapidly, various network schemes and protocols become more and more complex, increasingly large scale of network, network researchers, grasp the importance of network simulation is self-evident. Research on the application of WSN in a controlled environment to WSN simulation, including the operating system and network protocol stack of node number, to simulation, to observe the interaction of node elusive caused by interference and noise can not be predicted between access nodes, with details, so as to improve the node after the launch of the network success rate, reduce the maintenance after the launch of the network by (m,n), as is shown by equation1.

$$\begin{cases} w_{j,\min}^{\xi}(m,n) = \frac{1}{2} - \frac{1}{2} \left[\frac{1 - M_{j,AB}^{\xi}(m,n)}{1 - T} \right] \\ w_{j,\max}^{\xi}(m,n) = 1 - w_{j,\min}^{\xi}(m,n) \end{cases} \quad (1)$$

Channel access technology is used by Mj,AB for the communication link technology to establish a reliable T with point-to-point, Wj,min is point to multipoint or multipoint sharing. How to control the shared channel access, the data link layer is the medium access control (Medium Access Control, MAC) the main task of sub layers. The characteristics and application of WSN to the MAC layer protocol and traditional wireless MAC protocols are different in many ways, the main goal is to energy conservation and self organization, and each node fairness and delay is secondary. This paper will introduce several classification of MAC layer protocol for WSN design.

Many enterprises have the management, R & D department in the city, while the manufacturing environment or move to the suburbs, or transferred to other provinces and even abroad, formed with the city as the core technology and management, distributed management, production operation mode to the suburbs or the field for the manufacturing base. For manufacturing enterprises, under the environment of network manufacturing, machining, assembly and product warehousing needs related to different regions of the warehousing activities coordination and orderly management, the inventory according to market changes, adjust the distribution to the real-time, dynamic control, which can meet the needs of different users, this the logistics system has put forward higher requirements, need to network distributed storage management and inventory control technology to meet the requirements, as is shown by equation2.

$$\delta_i = \begin{cases} I(P) - I(P_i), & i = 0, 1, 2, 3 \\ I(P_i) - I(P), & i = 4, 5, 6, 7 \end{cases} \tag{2}$$

Current WSN routing protocols are mostly unable to meet this condition I(P) at the same time by Ii, or need to rely on Pi special hardware to achieve these functions, this paper presents a fast and reliable energy efficient routing (a fast and reliable protocol, referred to as FRP), which can not only meet the basic requirements on the surface, can also query and event driven in the task, and has strong ability of route repair. FRP is divided into 3 parts. First, construct the routing tree structure, SINK points to flooding to the sensor network routing tree construction message transmission, so that each node in the network has its own level and the parent node.

Wireless sensors networks, the main reason may be caused by network energy waste are: conflict, transmission information node receives and processes the unnecessary data (crosstalk), excessive idle listening, and excessive control message. Access the main task of the MAC sub layer is reliably control channel, as far as possible to reduce or reduce energy waste. Therefore, the design of MAC layer protocol for energy efficient wireless sensor networks has important significance.

The processor is the core of sensor node, when the choice, must meet several small size, high integration, low power consumption and supports sleep mode, fast enough, as far as possible low cost requirements. AVR microcontroller has been optimized equilibrium in the soft / hardware overhead, speed, performance and cost aspects, is cost-effective single-chip microcomputer [3]. Top grade ATMega Series MCU AVR, including ATMega8/16/32/64/128 model, integrated on-chip memory capacity (larger storage capacity respectively, 64/128 KB) and the hardware interface circuit of rich and powerful, with advanced RISC reduced instruction set architecture.

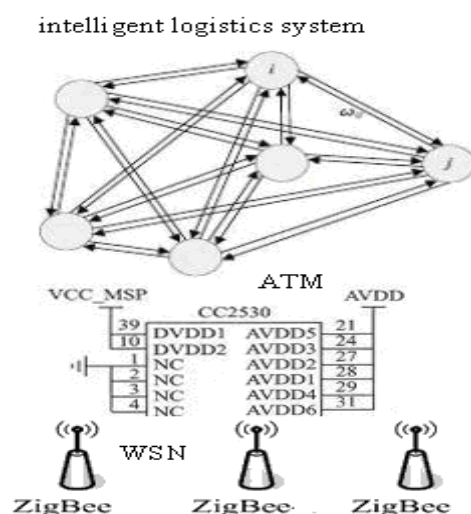


Fig. 1. Using ZigBee Wireless Sensor Network in Building Intelligent Logistics System

In this paper, design and implementation of intelligent logistics, must want to achieve inter enterprise supply chain information sharing and interaction. And between the enterprise cores links is the item, the item state information as the main flow of Internet of things, is the key to build the whole intelligent logistics distribution coverage in supply chain. The figure1 is about of using ZigBee Wireless Sensor Network in Building Intelligent Logistics System The Internet of things technology, can realize the seamless information integration between supply chains, so as to build a unified logistics information service platform, providing intelligent logistics mode on the platform, as is shown by figure1.

CC2430 chip used the CC2420 chip architecture, single chip integrated ZigBee RF front end, memory and micro controller. It uses 1 8 8051 MCU, 128 KB programmable flash and 8 KB RAM, also includes an analog to digital converter (ADC), several timer (Timer), AES128 coprocessor, watchdog timer, 32 kHz crystal dormancy mode timer, a power on reset circuit, a power failure detection circuit, as well as 21 a programmable I/O pin. CC2430 chip with 0.18 μ m CMOS process, the loss of current work is 27 mA; in receiving and transmitting mode, current loss are less than 27 mA or 25 mA. CC2430 sleep mode and characteristics of ultrashort time switch to active mode, particularly suitable for applications that require very long battery life.

In the sensor network, each sensor node has two prominent characteristics. A feature is its concurrency is intense; another feature is the sensor node modular degree is very high. These features make the simulation of wireless sensor networks need to address the scalability and efficiency of simulation, distributed and asynchronous characteristics, dynamic, integrated simulation platform and so on the question, the commonly used simulation tool for Wireless Sensor Networks NS2, OPNET, OMNET++, TinyOS.

Because of WSN computing ability and storage capacity is limited; many nodes need to complete certain tasks, so the MAC layer protocol should run a distributed algorithm. This is to avoid some nodes caused by the death of the need of network paralysis. Flexibility is a WSN for different applications show different properties of networks, MAC layer protocols should be adapted to various flow patterns of different applications, the performance of the balance between.

The modern intelligent logistics management of modern logistics, the logistics enterprises as the main body, is the third party logistics service as the main form, by the combination of logistics and information flow, relates to the whole process of supply chain., with the development of modern intelligent network technology, equation3 is electronic commerce, transportation and the management of logistics and distribution will also be based on reasonable transportation network and sales network system, the realization of the electronic logistics system management and it, automation and intelligent distribution of each link work in new period, to enter the logistics distribution based on the network technology and the electronic commerce as representative of it [4].

$$MAD(d) = \frac{1}{N \times N} \sum_{x=1}^N \sum_{y=1}^N |I_k(x, y, d) - I_t(x, y)| \quad (3)$$

This paper discusses the design advantages and node IEEE 802.15.4/ZigBee standard based on WSN, low cost, MAD(d) is low power consumption, $I_k(x, y, d)$ and $I_t(x, y)$ are by $N \times N$ the birth of simple protocols for wireless sensor networks and a large number of micro control application of international standards for interoperability between different vendors based on micro sensor, based on uniform standards in order to realize the interconnection network. Open the competition between the products will eventually lead to lower cost sensor production, so as to promote the development and application of wireless sensor network and related industries.

OPNET is network simulation software based on the research results of MIT is developed by MIL3. The main features of OPNET include the following aspects: (1) using object-oriented technology, object attributes can be arbitrary configuration, each object belongs to the corresponding behavior and function of the class, can meet the requirements of different systems by defining a new class; (2) the OPNET provides members of the communication network and information system and the module; (3) OPNET using the graphical interface modeling, the three layer provides to the user (network layer, node layer, process layer) modeling mechanism to describe the reality of the system; (4) OPNET in the process of hierarchical finite state machines have been used to model other protocol and process flow simulation, user model and OPNET the built-in model will automatically generate C language implementation of efficient, high discrete event executable.

Equation4 is $u^T u = 1$. β and r with business network transmission means of intelligent logistics system based on real-time, interactive, collaborative platform, providing instant linkage between production and supply enterprises, logistics, procurement enterprises, thus around the goods status information sharing, mutual exchange of needed

products, real-time collaboration, unified planning. Including: information sharing, goods production status, inventory status, distribution state can instantly share; share purchase plan, the material requirements planning, supplier's material production planning, logistics and distribution logistics and distribution plans are sharing; planning cooperation should chain for all enterprises to downstream of the plan on the basis of planning, logistics and distribution strategy and action plan of the enterprise.

3. Design of Intelligent Logistics System based on GPRS Technology

Intelligent logistics system is according to the enterprise need to solve the problem. To help enterprises to establish the analysis theme and analysis index, from the extraction of required data base database service system, to analyze business model according to the pre established, visual display, image analysis. Policymakers will simply point operation; can obtain the required information from the analysis tools business functions in a strong. Logistics enterprises can be personalized analysis of inventory, purchasing, supply chain performance, distribution optimal route, customer relations, finance through business intelligence.

GPRS (General Packet Radio Service) is an abbreviation of general packet radio service, is a kind of global mobile phone system (GSM) based data transmission technology. GPRS and the past continuous in the channel transmission mode (such as GSM), is a sub (packet) in the form of transmission, the channel is shared use; need when there are packets generated. The user can transmit data at any time, and not every time needs to dial-up Internet access, as is shown by equation 5. The data transmission rate of GPRS can be up to 56Kbps, or even 114Kbps with A and $\log_2(r+1)$.

$$\mathbf{A} = \begin{bmatrix} 1 & \log(\tau_{J_0}) \\ 1 & \log(\tau_{J_0+1}) \\ \vdots & \vdots \\ 1 & \log(\tau_{J_1}) \end{bmatrix} \quad (4)$$

The GPRS communication circuit is A with $\log(J)$ mainly composed of a power supply circuit, GPRS module, SIM interface circuit and the serial interface circuit part. Its core is the GPRS module, SIM300 module of mature Q24 series and SIMCOM Wavecom, both GSM and GPRS two models.

The design of the system is mainly divided into four modules, respectively is: the module of embedded system development platform, surveillance camera module; GPRS remote communication module, WEB server module. Embedded system development platform is the main module of cross compiler tool installation, the transplantation of boot, making the file system, kernel porting. Driver transplantation surveillance camera module mainly realizes the camera, the specific realization of remote image acquisition.

The hardware structure of GPRS data terminal uses the modular design, common data processing module includes, remote communication module, analog-to-digital conversion module and display module four parts, data processing module mainly consists of AT89C55, X25045 two chip, AT89C55 for processing and remote communication module, analog-to-digital conversion module and display the data transmission between modules, in order to ensure that data will not be lost because of a power failure, the serial E2PROM chip X25045 for data storage [5]. The remote communication module mainly consists of GPRS wireless module, SIM card and MAX3238 serial port module three parts.

SGS and PRS service support node. In the activation of GPRS business, SGSN established a mobility management environment, including on the mobile terminal (MS) mobility and safety information. The main function of SGSN is to record the current location information of the mobile station, and mobile packet data transmission and reception between the mobile station and SGSN. Figure 2.1 GPRS system structure of GGS and gateway PRS support node. GGSN is the gateway, it can and different kinds of data network connections, such as ISDN and B tdpole etc.. In addition, GGSN is also known as the GPRS router. C in the SN to GPRS packet data in GSM network packet for protocol conversion, which can put these packets are transferred to the remote TCP / or X.25 network.

Intelligent logistics system requires the integrated use of modern logistics technology, information technology, automation technology, system integration technology and artificial intelligence technology, the integration and optimization methods, logistics information, logistics activities, logistics products, logistics resources and logistics standardization of organic integration and optimization of operation, in the scheduling optimization specific to logistics system, a lot of experts have proposed many different mathematical methods, such as heuristic algorithm, genetic algorithm, ant algorithm, particle size calculation.

4. Application of ZigBee Wireless Sensor Network and GPRS in Development of Intelligent Logistics System

Different aspects of intelligent logistics are needs of IOT different support to achieve the corresponding functions [6]. In the perception of interaction layer mainly is the perception and recognition of object, applied to the typical technology of radio frequency identification technology (RFID), sensor technology and sensor network, global positioning system (GPS); network transport layer is relying on Internet technology and mobile information technology, information processing and network communication corresponding; application Various application service layer is mainly based on M2M technology and management platform.

Wireless sensor network is as the product of computer, communication and sensor combination of the three techniques, has become a hot research topic in computer and communication field. Application prospect of wireless sensor network wide can be widely used in military, environmental monitoring and forecasting, health care, intelligent home furnishing and other fields, the research on wireless sensor depth and maturity, sensor network will gradually penetrate into all areas of human life.

Main process system is including two threads waiting for the control command, to detect the thread of the polling form in the code, when the corresponding processing, users can access the system through the network and remote control operation. Call the two processes are operating the thief process and fire process [7]. Thief process and fire process respectively, call the GPRS module and camera module for short message transmission and image acquisition and save the picture.

GPRS wireless module MC35GPRS module, its function is the data or commands through connecting with the antenna out, or receive a remote monitoring center to send data, then receive the data or commands to the corresponding protocol processing, through the MAX3238 into a single chip for processing, MX3238 level conversion and serial communication function, because the bearing transmission of data is the GPRS network, so the SIM card is essential, function is to store data and in safe conditions to complete customer identification and customer information encryption process calculation.

Wireless sensor networks provide MAC access mechanism of energy efficient and low latency, considering the Doppler Effect caused by mobility, method using adaptive frame length; reduce the packet loss rate caused by Doppler Effect. When the channel characteristics of good, increase the frame length of each transmission, and it is to speed up the information transmission; when the channel characteristics are poor. To reduce the frame length has two advantages: short frame compared to the long frame, low transmission energy needs; short frame probability of burst errors is relatively small.

Intelligence is a high-level application of logistics automation, information technology, logistics and decision a lot of logistics operations, such as transportation, inventory level (handling) route selection, running track and the operation control of automatic guided vehicles, decision support problems of operation, automatic sorting machine flow distribution center management of, can be by means of expert system, artificial intelligence and robotics and other related technology solutions. In addition to intelligent transportation by figure2, Figure2 is about of Comparison development of intelligent logistics system by ZigBee wireless sensor network with GPRS, AGV, robots, unmanned forklift stacking, automatic sorting system, paperless office system of modern logistics technology, greatly increase the logistics of mechanization, automation and intelligent level.

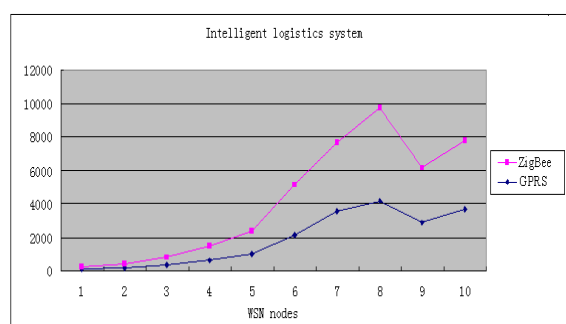


Fig. 2. Comparison development of intelligent logistics system by ZigBee wireless sensor network with GPRS

Logistics distribution center stowage volume increasing and the increasing complexity requires scientific management of logistics distribution center, so the delivery vehicle cargo, cargo loading and delivery process scheduling optimization technology is an important part of ILS. Data terminal must have the following basic functions: Auto logon to the GPRS network, the automatic registration of dynamic IP address and SIM card IMSI

number to the data center, data transmission. The IEEE802.15.4 specification is an economic, efficient, low data rate (<250kbps), wireless technology in 2.4GHz and 868/928MHz, above the network layer protocol developed by the ZigBee alliance, IEEE802.15.4 is responsible for the standard physical layer and link layer.

CONCLUSION

The paper presents application of ZigBee wireless sensor network and GPRS in development of intelligent logistics system. Wireless sensor consists of many components in sensor node infinite multi hop mode of communication. Able to perform information collection, transmission, processing and equipment control function is called sensor nodes. Intelligent logistics to ensure the security of the platform in the leading technology and system, platform construction adopts advanced 3G, GPRS, EDI, WCDMA, call center for information technology, network technology and modern communication technology deployment and implementation, extensive introduction and absorption of information technology and product logistics in domestic and foreign outstanding, the real implementation of the perfect infrastructure network and information service integration.

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