# Design and Implementation of Environmental Detection System based on ZigBee

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**Abstract.** With the continuous development of mobile Internet and Internet of Things technology, people's requirements for environmental quality are getting higher and higher. They are eager to use intelligent management systems to detect the environment. In this paper, wireless sensor network with low power consumption based on ZigBee can realize short distance wireless communication. Through distributed sensor nodes, all kinds of states in the environment can be obtained. The coordinator node can obtain the sensor state wirelessly and upload the server side through the serial port. PC and mobile terminals get environmental states with Internet communication. So that they cannot monitor the state of the environment in real time without being restricted by distance. Experimental results show that the system is stable and reliable and it can be monitored remotely in real time.

**Keywords:** ZigBee, WSN, Detection.

## 1. The System Architecture

With the continuous development of mobile Internet and Internet of Things technology, indoor environmental issues have also become the focus of people's attention. An intelligent indoor environmental monitoring system can be achieved. The detection system designed in this paper is based on the wireless sensor network of ZigBee technology. It can provide low power consumption and low-cost short distance wireless communication requirements. The architecture server is connected to the Internet to allow mobile users to obtain environmental information anytime and anywhere.

The overall design of the environmental monitoring system is shown in the figure. The ZigBee protocol for wireless communication is used between the coordinator and the wireless sensor node. The sensor node can be external to different types of sensors through the I/O interface of the common node. After the coordinator get the state of each sensor node, it can write configuration to the node to achieve duplex communication. The coordinator serves as a relay node to connect to the Internet server via a USB link port. The server can communicate with wireless routers via wired or wireless. Mobile users can access the server via a PC, table or mobile phone to obtain the state of the sensor or change the state of the sensor. The system is simple, cheap and stable.

## 2. ZigBee Protocol and Wireless Sensor Network

### 2.1 Zigbee Protocol

The ZigBee protocol is based on the IEEE 802.15.4 protocol stack and is a new short-distance wireless communication technology that is mainly used for low-rate network design. The operating frequency bands of ZigBee are 2.4 GHZ, 868MHZ and 915MHZ, and the transmission distance is within 10-75m. The complete ZigBee protocol consists of the physical layer, the medium access control layer, the network layer, the security layer and the high-level application specification. The physical layer and medium access control layer are based on the ISO protocol and are established by the IEEE 802.15.4 standard. The Zigbee alliance has developed a network layer, a security layer, and an application interface. Each lower layer provides a specific data transfer service for its corresponding upper layer. The system diagram is shown below.

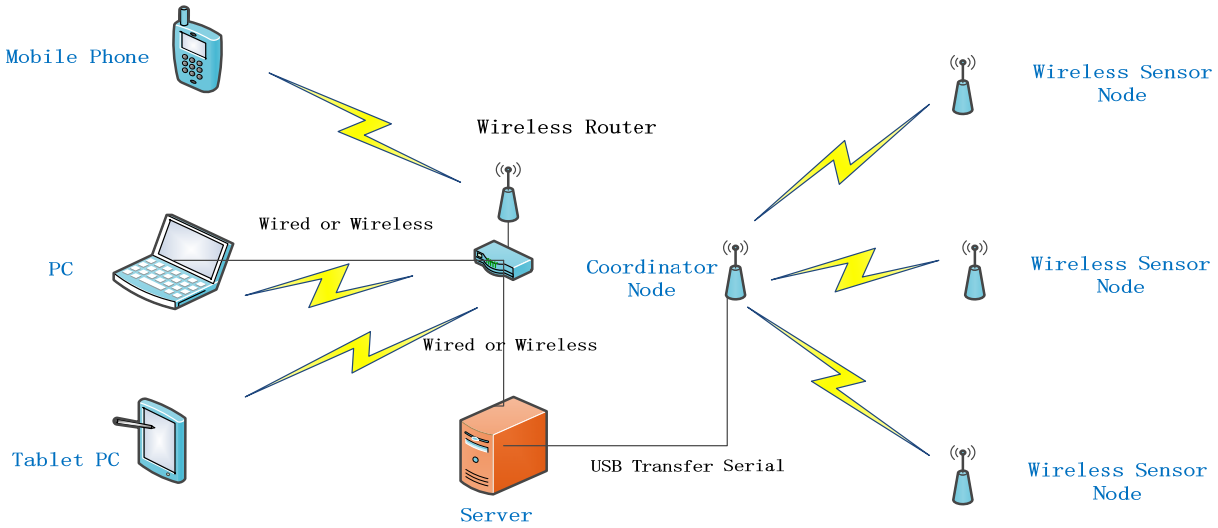


Fig 1. The Structure Chart of Wireless Sensor Network

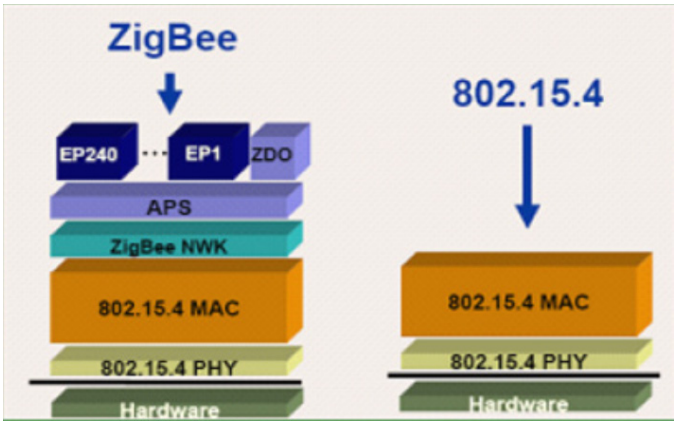


Fig 2. The chart of ZigBee protocol.

## 2.2 Wireless Sensor Network

Wireless sensor network has attracted more and more attention in the world at present, and it involves the frontier hot research field with high interdisciplinary cross and knowledge integration. It is a large-scale, self-organized, multi-hop wireless network without infrastructure support. It has extensive applications in many fields such as industry, agriculture, medical care, transportation, logistics, military, and individual families. Compared with its various existing networks, wireless sensor networks have remarkable characteristics: 1, the number of nodes is large, and the network density is large; 2, distributed topology; 3, the characteristics of self-organization.

The Zigbee network layer is mainly a function of adding, leaving, routing, and data transmission of nodes. There are currently two kinds of routing algorithms supported: network routing and tree routing. The network schemes of the supported wireless sensor network topology are: Star topology, tree topology and grid topology. These major topologies generally contain three types of devices: coordinators, routers, and terminals. The coordinator is the only switch device established in the entire network. As long as the network is established successfully, the coordinator function is equivalent to a router. It is responsible for the data exchange routing selection in the network and the security of the network.

Since ZigBee is a distributed wireless sensor network, other operations do not depend on the coordinator. The number of routers in the network is not large. The main function is to expand the network structure, implement multi-hop routing, and assist other nodes to complete network communication. In terms of practicality, tree and star networking methods are more suitable for the design of smart homes. This paper mainly studies the network topology implementation of tree

structures. The routing of tree networks is to regard the coordinator as the root of a tree. This way does not need routing table. The maximum storage space can be saved.

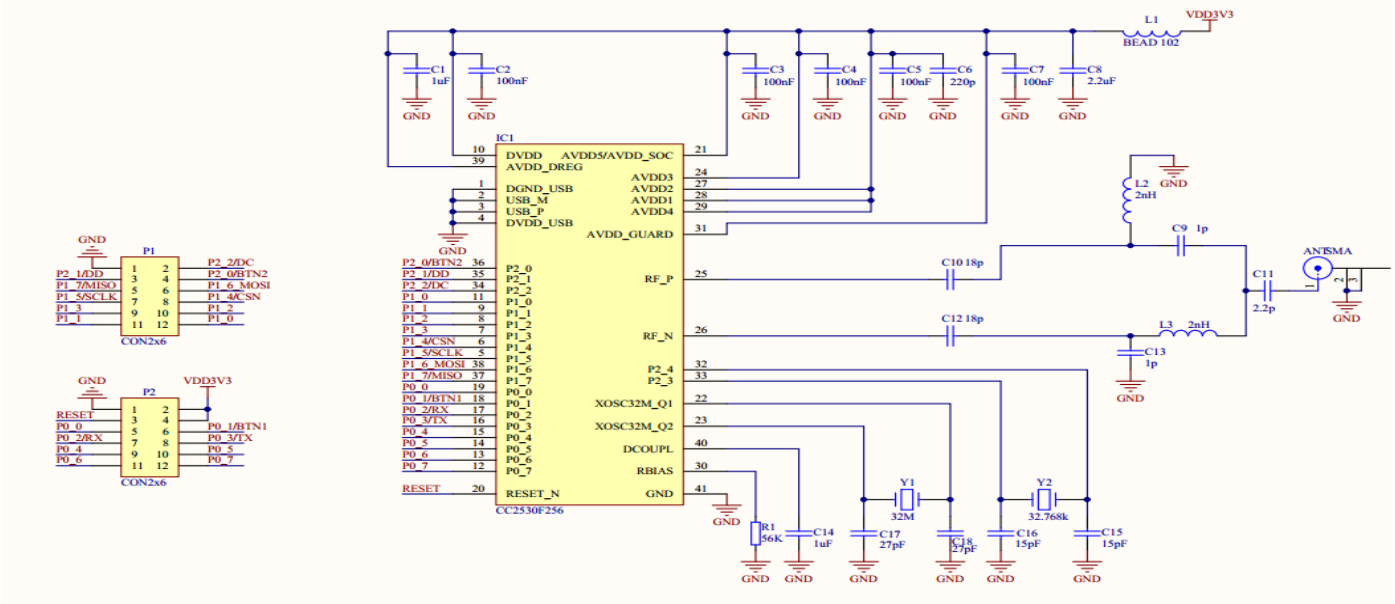


Fig 3. The diagram of CC2530 core circuit

## 3. Software and Hardware Design of Network Nodes

### 3.1 Hardware Design

Zigbee core board based on CC2530 chip mainly completed two major functions: First, it can complete the design of high-frequency RF circuit, to achieve wireless data transmission and transmission. The second draws out the I/O and other CPU resources of the core board to facilitate users to perform other functional extensions and secondary development. The core circuit is shown in Fig 3.

The CC2530 chip mainly includes a clock circuit and a high-frequency transceiver circuit. The clock circuit contains a clock oscillation circuit of 32.768 KHz and 32 MHz This circuit can ensure the real-time clock stability of the CC2530. The high-frequency circuit uses a mature integrated device 2450bm15a0002 to perform balanced and unbalanced conversion of radio frequency signals, which can avoid the performance instability caused by individual differences in independent devices.

The Zigbee node can be used for coordinating device nodes and wireless sensor nodes. It can expand the functions provided: reset keys, user keys, LED indicator lights, USB string ports, JTAG download interfaces, power selection switches, and all IOs through 2.54 standard spacing pins. Through the I/O interface, different types of sensors can be connected and the required information can be output. There are many kinds of sensors, which can measure and collect various target parameters.

### 3.2 Software Design of Network Node

The software design flow diagram of the universal node is shown as Fig4. After the system is Initialized, the node begins to collect external data and analyze and process it. The coordinator node communicates with the PC terminal to send data, and the sensor node sends data to the coordinator. Data are recollected only after the timing of arrival is interrupted. In this way, the state of the sensor node can be obtained by regularly refreshing.

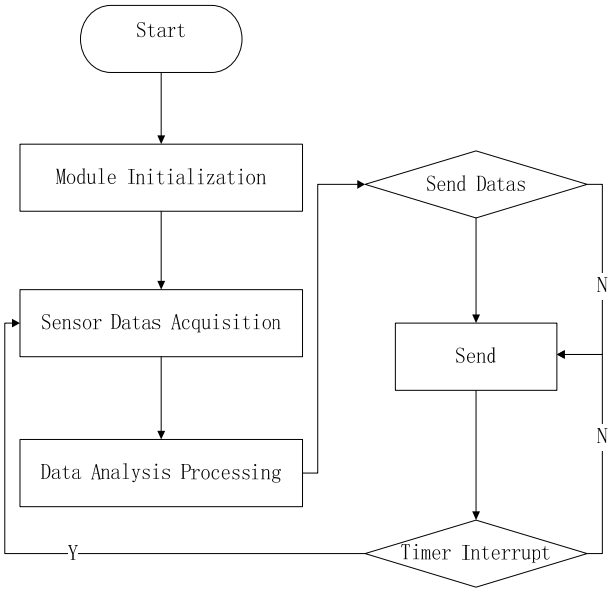


Fig 4. The flow chart of node software implementation

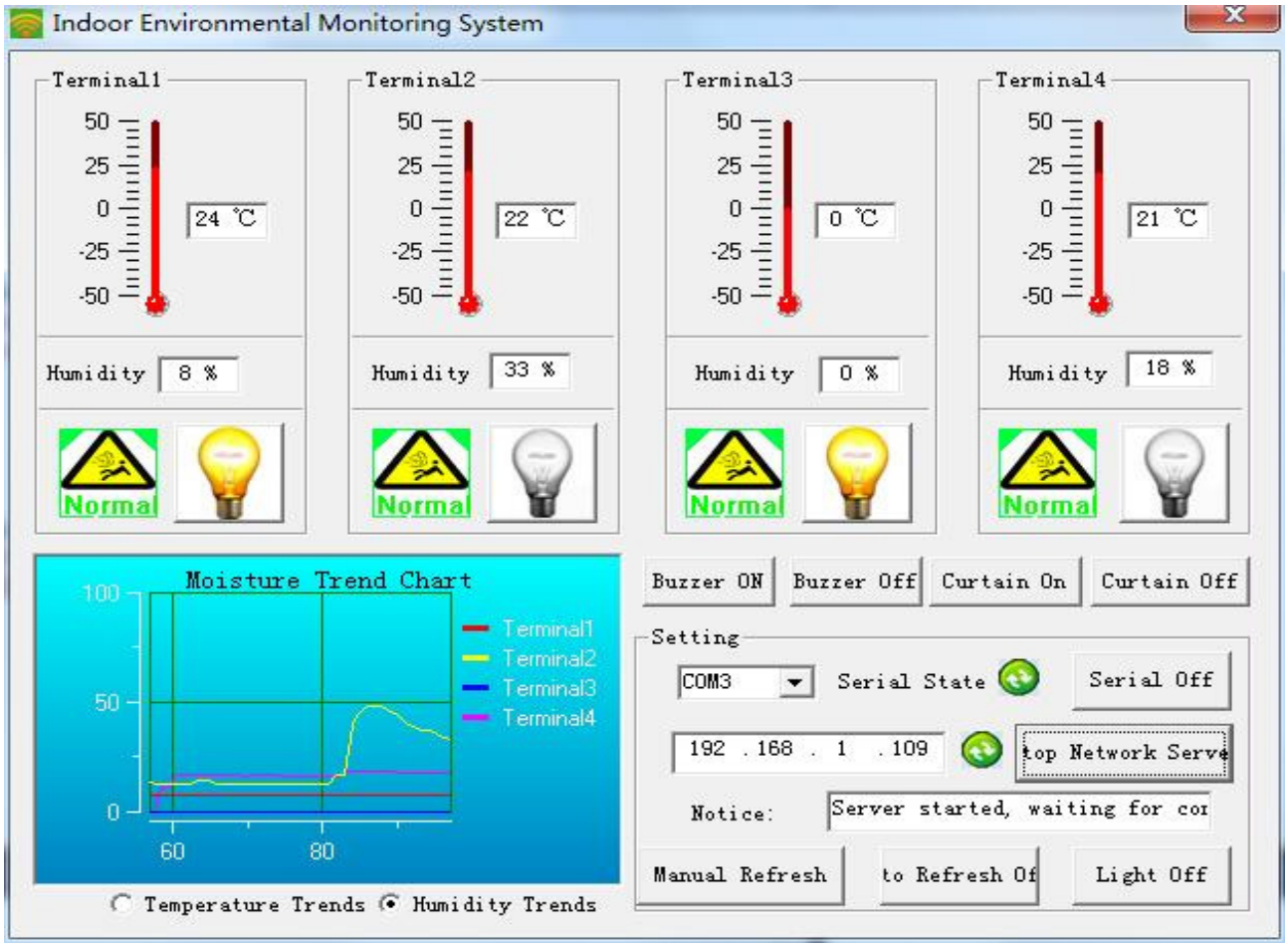


Fig 5. The diagram of PC terminal application

## 4. Experimental Results and Analysis

When ensuring that the coordinator is connected to the PC terminal and no other routing node is turned on, observe the status of the coordinator D1, D2, and D3 lights. The D3 light out means successful access to the network. Press the switch D1, and the D1 light out means that the data is received. Turn on the switch for each sensor node and press D1 to start the data. We can receive the

latest packet :3A 00 FF 01 18 08 01 01 15 0F 01 00 01 15 11 01 CA 23 through the serial port assistant. The following analysis of the meaning of the packet:

3A: Header
00 FF: Address
01: Function Mom
18 08 01 00: Sensor 1 state, 18 temperature, 08 humidity, 01 light state, 00 gaseous state
15 0F 01 01 : Status of Sensor 2
00 00 01 00: Status of Sensor 3
01 15 11 01: Status of Sensor 4
CA: Check code
23: End

Open the software and open the serial port connected to the corresponding coordinator. As shown in Fig5, the following interface can be displayed to open the network service. The state information of the sensor can be obtained through the Internet by connecting the IP to the mobile phone.

## 5. Conclusion

In this paper, the wireless sensor network based on the ZigBee protocol realizes the environmental detection system in the context of mobile Internet, and collects the environmental parameters from the system's overall design, hardware design and software design. The experiment proves the feasibility and reliability of the system. It has the characteristics of low speed and low power consumption, and it has a good network effect in a limited controlled distance. It is light, flexible, and low cost and easy to achieve. Used for small scale monitoring at home or office. At present, it is limited to sensor technology, and some parameters cannot be collected. However, the system retains the extended functions of hardware and software. Later can be added at any time. Therefore, the system has a strong use value in the mobile Internet era.

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