# The Curriculum Construction of Wireless Sensor Networks for the Internet of Things Engineering

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## Abstract

Wireless sensor networks(WSN) is a new technique and the core course for Internet of Things(IoT). According to the course characteristics, this paper analyses the difficulties and challenges for the curriculum construction firstly, and then the basic ideas of curriculum construction are proposed. Nextly, the main curriculum contents of WSN are designed into three parts: basic theory teaching, curriculum experimental teaching and WSN comprehensive experiments, which can make the students grasp the course contents and experimental operations systematically, and improve the teaching effect, and that the application abilities of students will be further developed.

## Keywords

Wireless sensor networks (WSN), Course content, Curriculum system, The Internet of Things Engineering.

## 1. Introduction

In August 2009, Premier Wen Jiabao firstly proposed the core strategy of "Sensing China“ in Wuxi, and the Internet of Things(IoT) was included in the "Government Work Report" in 2010, which was officially listed as one of the five national new strategic industries[1]. In order to strengthen the personnel training for the IoT industry, in March 2010, the notice of the declarations and approvals on the related fields of strategic emerging majors were issued by the Office of the Ministry of Education, which pointed out: "Strengthen the support of personnel training of strategic emerging industries, and support and encourage some colleges and universities to accelerate the reform and innovation of teaching contents, course system, teaching methods, and management system and operation mechanism from the undergraduate education, and actively cultivate the relevant professional talents of new strategic emerging industries, which can meet the urgent demand for the high-quality talents by the national strategic new industries". By 2013, more than 150 colleges and universities across the country had set up the major of IoT Engineering, which had an enrollment of more than 8000 students[2].

The IoT Engineering belongs to the Engineering, which is mostly depend on the Computer Science or Electrical Communication Engineering, and the WSN is one of the core technologies of the IoT, and the course of WSN is not only listed in the core courses of the IoT Engineering by most of colleges and universities, but also included as the compulsory courses for the graduate or senior undergraduate of Computer, Electrical Communication, and other related majors by many colleges and universities. In September 2014, the Yangtze University enrolled the first student body in IoT Engineering from the candidates of College Entrance Examination relying on the College of Computer and Science. In 2012, we began to explore and practice the course teaching of WSN for senior undergraduate and graduate students in major of Computer Science and Technology.

## 2. The characteristics and requirements of WSN curriculum

The WSN curriculum involves computer, microelectronics, sensor, network, communication, data analysis and processing, and many other areas, which is a comprehensive curriculum of practical application oriented, and high interdisciplinary. Its practical application requirements are high, and the teaching contents are difficult, whose main problems are as followed:

(1) The curriculum theory teaching hours is few, but its contents are too wide, which covered from hardware to software, a single node to the whole perception network, and the perception layer to application layer. Therefore, the WSN course is a comprehensive curriculum and its teaching is difficult.

(2) The technology of WSN is in a high-speed development stage, which leads to the curriculum contents are not unified and change fastly, and the teaching work is mainly in the form of laboratory studies for graduate students and doctoral students. In addition, the teaching contents construction of this course are not identical in each university, and the theoretical teaching and experimental teaching resources are rarely to refer to.

(3) WSN curriculum is practical course, which needs a variety of different types of experimental apparatus, instruments and equipment, as well as a variety of development environment and a larger experiment site to achieve complete effect, so it requires teachers to choose appropriate teaching auxiliary tools according to their own actual situation.

(4) The IoT Engineering is also a new major in our country, whose course contents cutting and course sequence is not very standard between WSN curriculum and other related curriculum.

(5) WSN curriculum as the new and core curriculum of undergraduate majors in IoT Engineering which was set up the first time in our school, the course team, teaching experience and the accumulation of teaching resource all have some shortcomings.

## 3. Curriculum content designing

On the contents designing of WSN curriculum, we put forward the teaching philosophies of taking the theory teaching as target, the teaching process as case and the practice resources as module, on the base of deep investigation and extensive collection of WSN related books, textbooks and public published course website in the domestic and foreign[3-9]. We simplify the theory teaching contents, select the typical cases, highlight the practical application and construct the practice resources as modules. And in practice, we design three parts for WSN curriculum contents: the basic theory teaching, curriculum experimental teaching and WSN comprehensive experiments.

### 3.1 The basic theory teaching

Contents are organized as followed:

1. Summary of WSN. The main contents include the basic concepts and characteristics of WSN, performance indexes, development history, main application fields and development platforms.

2. Setting up WSN. The main contents include the network architectures, topology control technologies, communication network technologies (MAC protocol, routing protocol, and the application layer protocol), support technologies (time synchronization, positioning, energy management, and fault tolerance technology) and protocol standards (ZigBee, Bluetooth, Wi-Fi, and UWB), etc.

3. Data acquisition and data processing. The main contents include data acquisition and data processing algorithms and technologies.

4. The case study. The main contents include the latest research progress of WSN in industry and academia.

The specific contents and schedules are shown in table 1.

### 3.2 The Curriculum experimental teaching

In the Curriculum experimental teaching, we design three experiments based on Zigbee WSN protocol development experimental apparatus with CC2530 that include fundamental experiments, one intermediate experiment and one senior difficulty experiment, which are shown in table 2.

Tab.1 Contents and schedules of the basic theory teaching

| Chapter | Main contents | Class hours |
|---|---|---|
| Chapter 1 | Basic concepts, characteristics, performance, application and development history of WSN | 4 |
| Chapter 2 | Development environment for WSN | 2 |
| Chapter 3 | Topology control and covering technology of WSN | 4 |
| Chapter 4 | Communication and networking technology (MAC protocol, routing protocol) of WSN | 10 |
| Chapter 5 | Support technology (time synchronization, positioning) of WSN | 4 |
| Chapter 6 | Data administration of WSN | 2 |
| Chapter 7 | Agreement technical standards（ZigBee）of WSN | 10 |
| Chapter 8 | WSN Application | 4 |
| Chapter 9 | WSN and Internet of Things | 2 |
| Chapter 10 | Specific exchanges | 2 |
| | total | 32 |

Tab.2 Contents and schedules of the curriculum experimental teaching

| No | Experimental contents | Class hours | Experimental type | | | |
|---|---|---|---|---|---|---|
| | | | Demonstration | Verification | Comprehensive | Design |
| 1 | Fundamental communication experiment | 4 | | √ | | |
| 2 | Ad hoc network experiment | 4 | | | √ | |
| 3 | ZigBee experiment | 4 | | | | √ |

### 3.3 WSN comprehensive experiment

WSN comprehensive experiments integrate the elements of verification type experiment, design type experiment and open type experiment, which causes the student to start from the basic function and arouses the learning enthusiasm of WSN, and improves the students' engineering ability. Course experiments require students to work in a groups of 2 or 3 students, which requires that each team members have a clear division of labor cooperation and coordination among team members, and which cultivates the students' team spirits.

(1) Rudimentary Knowledge (teaching): reviewing the basic concepts of WSN, topology structures, network modes, characteristics and advantages, and four comprehensive experiments in detail.

(2) ZigBee basic experimental (verification): In basic experiments, students are required to complete basic experimental contents based on CC2530 chip development kits, such as:understanding ZigBee protocols, mastering the IAR software and completing the point-to-point communication etc.

(3) Medium experiment (design): The main contents include adding routing nodes, building multiple WSN, analyzing the process of data transmission protocol, and drawing flow chart on the basis of the complete basic experiments etc.

(4) Advanced experiment (open) : supporting students to complete four developmental experiments such as logging information acquisition system, building security information acquisition system, forest fire monitoring system and flood monitoring system, which are shown in table 3.

Tab.3 Contents and schedules of WSN comprehensive experiments

| No | Experimental contents | Teaching | Experiment | Total |
|---|---|---|---|---|
| Experiment 1 | Logging information acquisition system | 2 | 6 | 8 |
| Experiment 2 | Building security information acquisition system | 2 | 6 | 8 |
| Experiment 3 | Forest fire monitoring system | 2 | 6 | 8 |
| Experiment 4 | The flood monitoring system | 2 | 6 | 8 |
| | total | 8 | 24 | 32 |

## 4. WSN curriculum group

As a new major, the plan of training talented persons for the IoT Engineering needs to be constantly adjusted in practice, especially the course contents coordination among the WSN curriculum group, which determines the position of WSN course in the curriculum system of IoT, and which clarifies the contents cutting and sequence of curriculum arrangement among the WSN curriculum group.

The discipline foundation of IoT Engineering generally relies on Computer Science and Technology, Information and Communication Engineering, Intelligent Science and Technology, and Control Science and Engineering and other main subjects. The contents involve four aspects: information perception, information transmission, information processing and the field application. The undergraduate course knowledge system for the IoT Engineering is shown in figure 1.

The curriculum group of WSN contains various courses which have relevance and integration from the contents point of view. We have designed the teaching architecture of WSN curriculum group, which includes the Computer Composition Principle, Embedded Principle and Interface, Computer Network and Wireless Sensor Networks. The curriculum group of WSN is shown in figure 2. The corresponding course units and develop capacity of backbone courses in WSN curriculum group is shown in table 4.

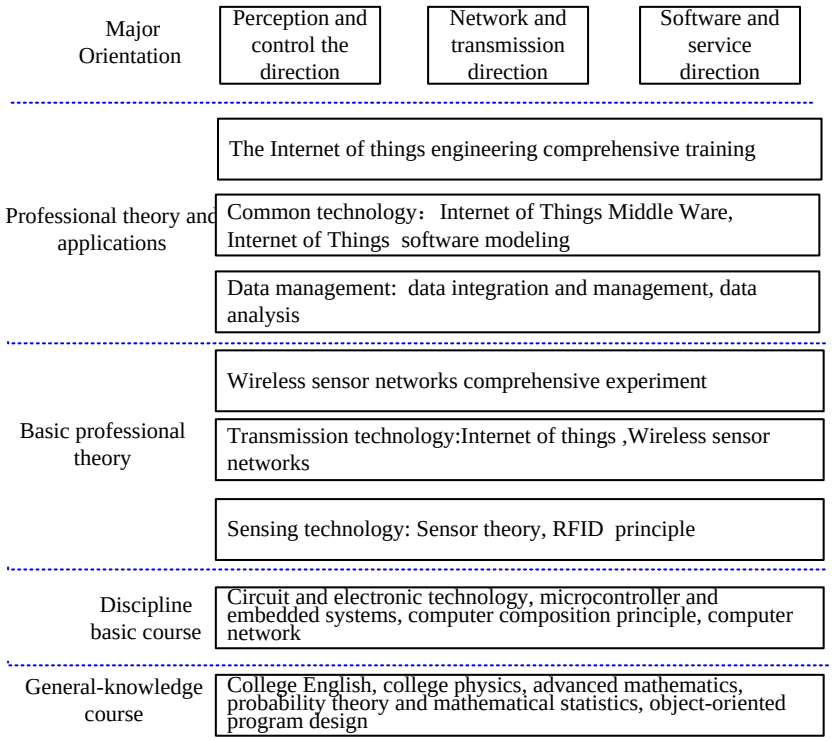


Fig.1 Undergraduate course knowledge system for the IoT Engineering

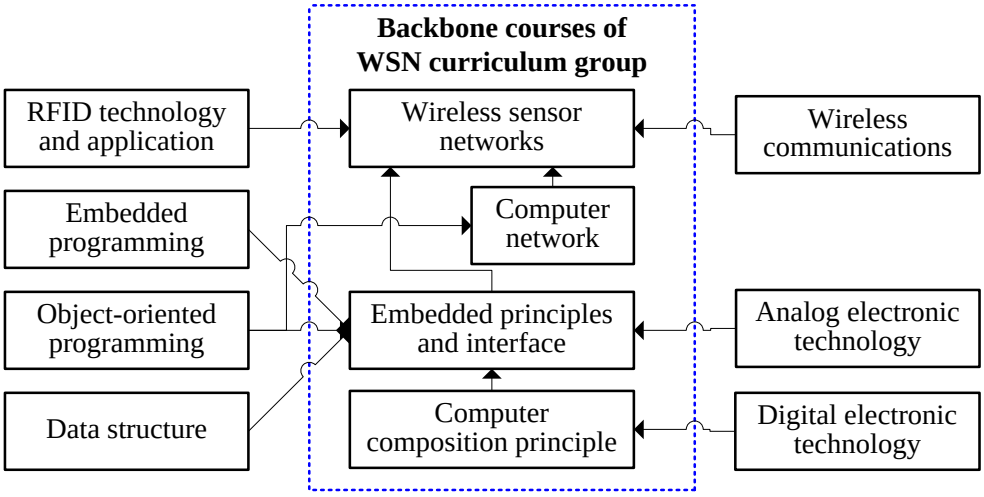


Fig.2 The curriculum group of WSN

Tab.4 The corresponding course unit and develop capacity

| Theme | Computer composition principles | Embedded principles and interface | wireless sensor networks | computer networks |
|---|---|---|---|---|
| main knowledge points | (1)The CPU composition architecture;<br>(2) Memory principle;<br>(3)Principle of input and output interface;<br>(4)Interrupt/DMA principle | (1) The composition of ARM9 kernel structure;<br>(2) The storage control and management of ARM;<br>(3) The interface control of UART/USB/GPIO<br>(4) Interrupt application development | (1)CC2530 structure<br>(2)Sensor storage management;<br>(3)CC2530 interface control;<br>(4)Sensor network and data transceiver. | (1)Network architecture;<br>(2)The data link layer protocol;<br>(3)The network layer protocol;<br>(4)The transport layer protocol;<br>(5)The application layer protocol. |
| Main capacity requirements | The whole computer concept | The application development based on microprocessor | The application development based on sensor. | The design and analysis, application development for LAN and Internet |
| In-class experiments | (1)Arithmetic unit and controller;<br>(2) Read and write memory ;<br>(3) The I/O interface;<br>(4) Interrupt | (1)The processor working mode;<br>(2)Storage reading and writing ;<br>(3)LED control and serial ports, etc;<br>(4)Interrupt application development | (1)The processor basic experiment;<br>(2)Flash/RAM functions and management;<br>(3)Z-Stack experiment;<br>(4)Temperature and humidity sensors | (1)LAN network fault analysis and ruled out;<br>(2)Switch configuration;<br>(3) VLAN configuration<br>(4)Router configuration |

## 5. Conclusion

The WSN is a comprehensive course. At present, the technology of WSN is in a rapid development stage, its teaching contents span widely and its comprehensiveness and practicality bring many challenges to students' learning. So we need some courses in former sequence to lay the foundation, such as Wireless Communication, Computer Network, Computer Composition Principle, Embedded Systems and Computer Language etc. WSN curriculum will integrate these isolated courses into a complete application system.

The knowledge of these courses for different students in the colleges and universities is different, and the understanding of curriculum and experimental operation have different insights. This requires teachers to put the knowledge design into module and to teach students or decorate students flexibly according to students' actual situations. At the same time, the verified experiments and designed experiments should be increased into curriculum experiments, which can furtherly improve the students' abilities of WSN system development.

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