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DESIGN & IMPLEMENTATION OF TEACHER STUDENT INTERACTION SYSTEM USING ZIGBEE & RFID

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Abstract: Research of the past years has led to numerous novel developments and approaches for wireless sensor networks (WSNs). However, most previous work has focused on either mathematical analysis or theoretical algorithms with extensive simulation results. In this paper, in order to realistically understand the complexity of WSNs, a ZigBee/IEEE 802.15.4 platform has been designed and implemented. Based on an IEEE 802.15.4 radio and ZigBee protocol stack, the developed ITRI ZBnode is an autonomous wireless communication and computing platform aimed at fast prototyping and research in WSNs. The platform attempts to provide a low data rate, low power, and low cost wireless networking on the device-level communication. Finally, examples of tree and mesh network formation are provided to demonstrate practicability of the developed ZBnode platform.

Keywords: *wireless sensor networks module; ZigBee; RFID; teaching interaction system*

1. INTRODUCTION

In recent years, RFID technology in the logistics field has been widely adopted, it is recognized as one of the industry's most important industry and application technology in this century. The unique function of RFID is to mark any thing or person of the real world, in the virtual world of network; it has three functions as "tag", "address number" and "sensing". A wireless sensor network (WSN) is composed of hundreds or even thousands of such sensor nodes which use wireless links to perform distributed sensing tasks. we implemented a protocol stack of ZigBee using method of module dividing. From the perspective of improving teaching methods, combining teaching practices, a teacher-student interaction system based on ZigBee and RFID technology was designed and implemented for the application of actual teaching. Results show that the system achieved the basic functions of a teacher-student interaction system. Sensors come in many types to monitor a wide variety of conditions, such as the temperature, humidity, smoke, and light. The variety in types of sensors has received intensive research attentions due to its enormous application potential in environmental monitoring, military surveillance, biomedical supervision, and other fields [1]. Since the location of the sensor nodes may not be known in advance, there is a demand for the network to coordinate in a distributed manner, similar to the self-organizing capabilities of a mobile ad hoc network (MANET). However, several differences exist between WSN and MANET as described in the following.

* The number of sensor nodes deployed in a WSN is expected to be several orders of magnitude higher than the number of nodes in a typical MANET.
* Sensor nodes may be more densely deployed, and they are also limited in power, computation and memory capacity.
* Sensor nodes are prone to failure, destruction, and energy depletion, and hence the topology of the WSN changes frequently for these reasons rather than from node mobility.
* Sensor nodes may not have global identifiers due to the amount of overhead assigning such identifiers for a large numbers of sensors.
* The WSN tends to operate as a collective structure, addressed by attribute, instead of supporting many independent point-to-point flows. Thus, traffic tends to be variable and highly correlated.

Hence, protocols designed for MANETs are not directly usable in WSN due to these differences and several approaches have been proposed specifically for such WSN applications [2-4]. Moreover, these applications require low power consumption, low complexity in wireless links, and low cost (relative to the device cost). So far, IEEE 802.15.4 [4-6] standard is the one that addresses these types of requirements.

In order to fully understand the WSNs from a practical perspective, it is necessary to implement and test on real-world systems. However, most previous work has focused on the mathematical analysis and theoretical algorithms with extensive simulation results. In this paper, a ZigBee over IEEE 802.15.4 platform, named ITRI ZBnode, has been designed and implemented for WSN utilization and verification. Moreover, we will show the examples of tree and mesh network construction. Thus, our focus will be very much on the functional side of multi-hop topology formation and not so much on the algorithmic study[3].

2. ZIG BEE TECHNOLOGY

ZigBee technology is a kind of uniform technical standards for short-range wireless communication technology. Complete ZigBee protocol stack is formed by the physical layer, media access control layer, network layer, security layer and application layer. The physical layer and media access control layer protocol is the protocol standard IEEE802.15.4.The network layer and security layer were developed by the ZigBee Alliance, the development of application layer can be adjusted according to the user's own need. The system of ZigBee module of block diagram shown in Figure 1.

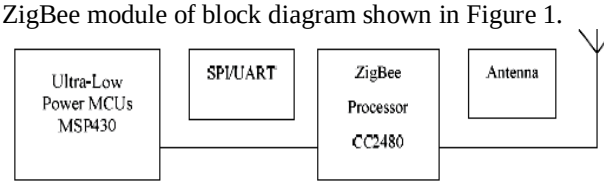

Figure 1. ZigBee module block diagram of the system

The ZigBee stack architecture [8] is made up of a set of blocks called layers. Each layer performs a specific set of services for the layer above, including a data entity provides a data transmission service and a management entity provides all other services[2]. Each service entity exposes an interface to the upper layer through a service access point (SAP), and each SAP supports a number of service primitives to achieve the required functionality. The ZigBee stack architecture, as shown in Fig.2 is based on the standard open systems interconnection (OSI) seven-layer model but defines only those layers relevant to achieving functionality in the intended market space. The IEEE 802.15.4 [6] defines specifications of the physical layer (PHY) and medium access control sublayer (MAC) for supporting simple devices that consume minimal power and typically operate in a personal operating space (POS). The ZigBee Alliance builds on this foundation by providing the network (NWK) layer and the framework for the application layer, which includes the application support (APS) sub-layer, the ZigBee device object (ZDO) and the manufacturer-defined application objects.

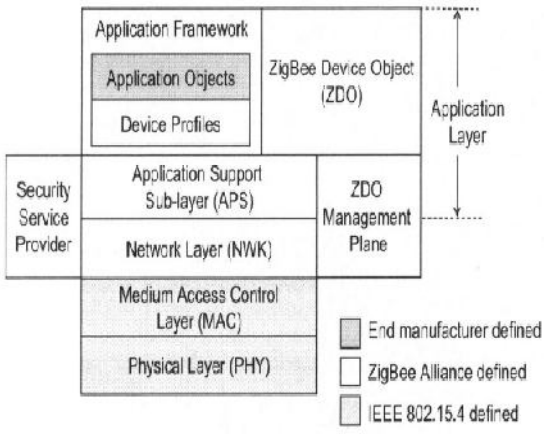

Fig.2. ZigBee Stack Archtiecture

3. SOFTWARE ARCHITECTURE

The software on the ZigBee wireless sensor network devices is mainly composed of embedded operating system software, ZigBee protocol stack and application program, embedded operating system kernel provides a simple and efficient task transfers, interrupt handling and time queue management, also includes all the underlying hardware driver. Applications program include serial communications, RF communications, and signal strength detection. It uses modular design protocol stack, makes the whole System-level clear, good scalability, conducive to the secondary development of ZigBee technology[2].

Stack Design

ZigBee protocol stack to ensure that wireless devices in the low-cost, low power and low speed network interoperability. ZigBee protocol stack of different layers communicate through the service access point, Most layer has two interfaces: data entity interface and management entity interface. Data entity interface goal is to provide top service routine data. Management entity interface goal is to provide the mechanisms including access to the upper inside layer parameters, configuration and data management. Its basic structure as shown in Table 1.

TABLE I. THE STRUCTURE OF THE ZIGBEE STACK

Applications	ZigBee Device object
Application layer (APL.h/APL.c)	Application Support Sublayer(APS.h/APS.c)
Network layer (NWK.h/NWK.c)	
Link layer media (MAC.h/MAC.c)	
Physical layer (PHY.h/PHY.c)	

ZigBee technology has defined the standard specification of the physical layer, link layer and network layer, therefore, the realization of these three layers are usually similar. Wireless sensor network's different applications are composed from the basic application, such as join the network, break away the network, send data, etc. This article uses the IAR Embedded Workbench for 8051 software to program the physical layer, media-link layer and network layer code of the system platform, each of the header file defines each layer of the support of the services and application program interface. Meanwhile, the platform also provides a number of application interface, for example aplFormNetwork (), plJoinNetwork (), aplSendMSG (), etc. Users can call these functions to achieve their development and application.

4. HARDWARE IMPLEMENTATION

The teacher-student interaction system consists of RFID systems with ZigBee subsystems, can enhance

the learning interaction between students and teachers, also can effectively manage students in class attendance and student learning outcomes and the progress to absorb knowledge. Teachers can keep abreast of the progress of students and enhance the students less familiar course content. Students may also rely on this system to effectively communicate and interact with teachers, to unfamiliar places for learning and ask questions at any time, to avoid face to face embarrassing questions or omission may be key.

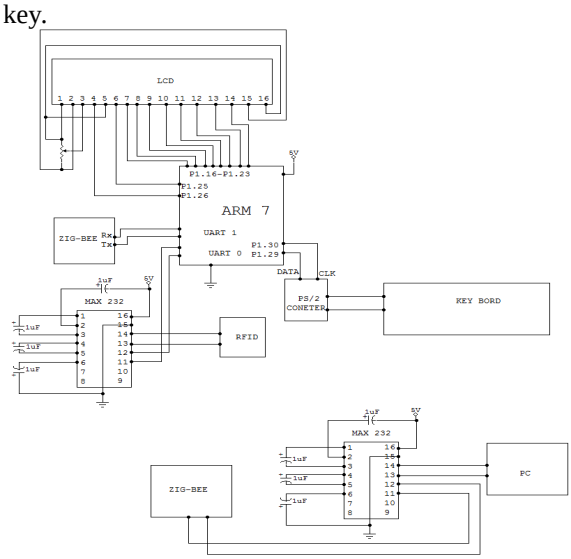

Fig.4. Circuit Diagram

In this paper, RFID and ZigBee combination, use RFID data for wireless interactive communication, to achieve the interaction between students and teachers, such as questions, answers, voting, attendance, assessment and other functions.

Each elective course students are assigned to a student tag, every seat in the class room table with a simple reader (Reader) subsystem, after students enter the classroom, the table reader subsystem can automatically sense and read the student tag, then the reader will send the information via ZigBee wireless to the podium of the main system, through the main system, teachers can know how many students school, attendance records of students, and make statistics.

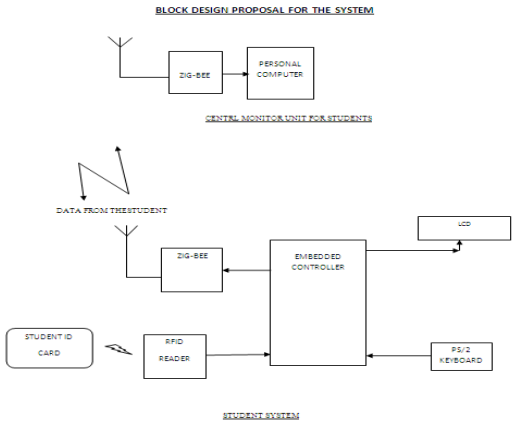

Fig.5. Block Design Proposal

Students subsystem is equipped with 3 buttons and LEDs, students can push the yes or no button on the subsystem, (to know or do not know) to answer teachers' questions, by ZigBee wireless, the answer back to the main system on the podium, the main system with a display subsystem to display the corresponding keyboard keys and control, student status and location can be displayed through the display, teachers can monitor the students' real-time understanding of the course and to grasp the situation, give supplement according to the situation, through the key board. Student and teacher can be communicated via a chat using their keyboards. Students end system architecture shown in Figure 5, 6 & 7.

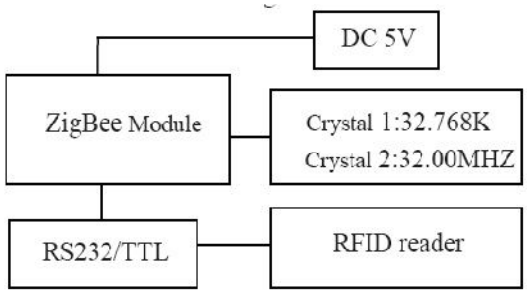

Fig.5. Student's End system Architecture

5. CONCLUSION

802.15.4 wireless technology, this paper has presented the implementation of a ZigBee-ready platform: ITRI ZBnode for WSN applications. In this paper, the combination of RFID and ZigBee way to achieve the interaction between students and teachers. RFID technology used for data acquisition and transmission, ZigBee wireless transmission module using a star network topology, to achieve the data from students end to teachers end node for wireless transmission.

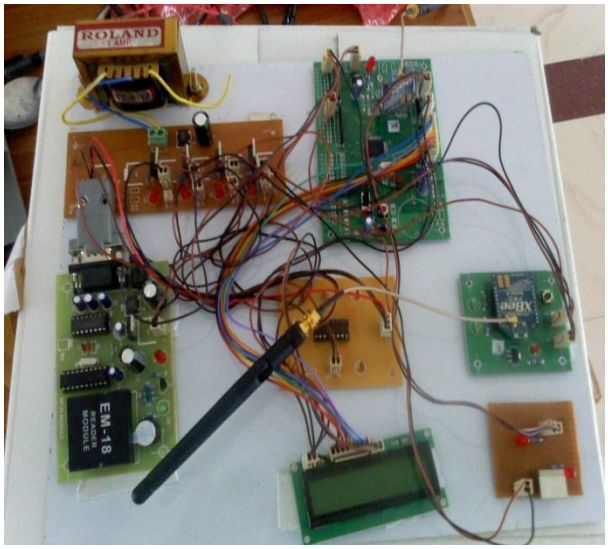

Fig.6. Teacher's End system display captured

Also, network formation of tree and mesh topologies has been demonstrated via practical experiments.

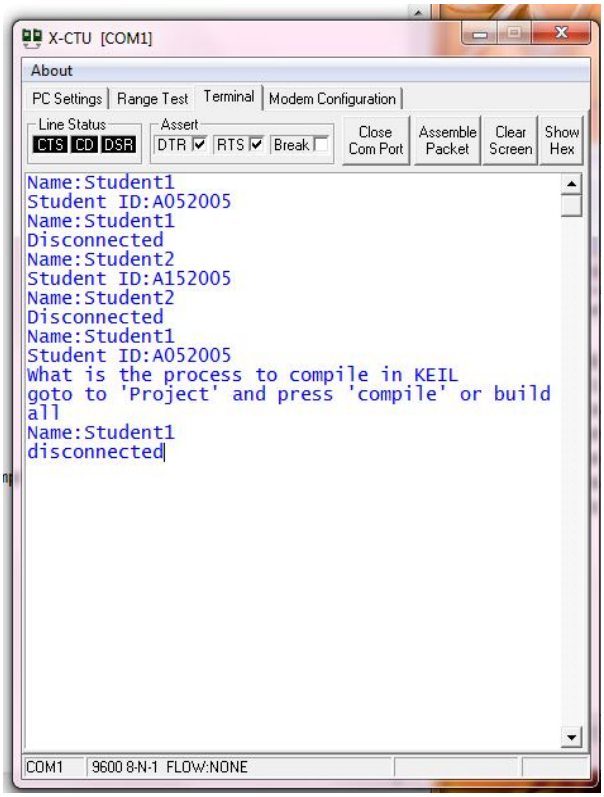

Fig.7. Teacher's End system display captured

So far, several IEEE 802.15.4 platforms have been available on the market. Table II compares ITRI SCAN-ZB32 with other commercial platforms. Moreover, Fig. 8 compares their physical models including main nodes (with computing and communication modules) and sensor modules. With a more powerful 32-bit processor and Linux kernel, ZB32 is very suitable for practical implementation and verification of complex algorithm and theory. The results show that, the system can implement the basic functions of student-teacher interaction system. The system of ZigBee wireless sensor networks and RFID radio frequency identification technology, modular design, with the characteristics of scalable. Slightly modified, the application can be ported to other systems.

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