Design of Smart Campus using Zigbee based on USN

Byeongtae Ahn*

Liberal & Arts College, Anyang University, Anyang-shi, South Korea. Email: ahnbt@anyang.ac.kr

Abstract. Universities that have been pursuing informatization with the development of high-speed networks and IoT (Internet of Things) are expanding the informatization area by introducing online academic administration systems, mobile campuses, and electronic libraries as part of the recent smart campus construction. As key technologies in this ubiquitous rank, the Ubiquitous Sensor Network (USN) along with radio frequency identification (RFID) and zigbee are emerging. In this paper, we propose an integrated management system model for the establishment of a smart campus, such as a digital library system and a smart card system capable of providing various services using zigbee, which is currently prominent. The integrated management system can provide a higher quality education environment through transparent and efficient administrative management and one-stop service provision, away from the labor-intensive system of educational institutions, and users can provide personalized and knowledgeable intelligent education services that meet their needs and environments.

Key Words : *Smart Campus, Sensor, IoT, Zigbee, USN*

1. Introduction

Recently, due to the rapid development of information and communication technology, network infrastructure has been widely distributed, and as various advanced digital equipments are becoming more common in everyday life, the ubiquitous era based on this is coming. Various attempts are made to incorporate the new paradigm into education, and there are factors that can evolve educational methods or efficiently support all activities related to education. Already, many advanced countries are trying to build a smart campus that applies ubiquitous computing technology to university campuses with this in mind. The aforementioned smart campus refers to a campus that supports convenient and safe activities of campus members with ubiquitous computing technology using small computer technology and wired/wireless network technology. Currently, smart campus-related research is actively underway, and technology is being developed accordingly[1].

In this paper, according to this trend, we propose a smart campus design suitable for junior colleges using zigbee wireless communication technology. Chapter 2 of this paper examines the research overview of smart campus and wireless communication technology for building smart campuses, and Chapter 3 examines the current status of smart campuses at home and abroad. And in Chapter 4, Smart campus's service is designed considering the characteristics of junior colleges, and in Chapter 5, service design for each field is proposed. Chapter 6 compares the efficiency through sensor networks with universities that have built a smart campus, and Chapter 7 presents conclusions and future tasks.

2. Research overview of Smart Campus

A smart campus refers to a campus in which the user who uses it for the movement of knowledge and information, which is the center of the campus environment, is intelligently moved without conscious awareness of nearby devices. The smart campus is based on the latest computing technology and network infrastructure currently available, and for this, it is necessary to construct a network infrastructure to realize ubiquitous computing services. In

this paper, we introduce major technologies for network infrastructure construction for the sensor network environment, which is the center of constructing such a smart campus[2].

	2.4 GHz	868 MHz	915 MHz
Data Rate	250 Kbps	20 Kbps	40 Kbps
Channel	11~26channel	1 channel	10 channel
DSSS	32-chipPN codes	15-chip PN codes	
Chip Modulation	O-QPSK	BPSK	
Symbol Rate	62.5 Ksym/s	20 Ksym/s	40 Ksym/s
Chip Rate	2.0 Mchips/s	300 Kchips/s	600 Kchips/s
Sensitivity	-85 dBm	-92 dBm	
RF Linearity	-10 dBm (IIP3), -4 dBm (Output P1dB)		
Transmit Power	0 dBm (1mW)		
Adjacent Channel Rejection	0 dB		
Alternating Channel Rejection	30 dB		

Figure 1. Compare of zigbee standard & stack

The following Figure 1 compares the standard and main stacks of zigbee technology. The u-sensor network (USN) technology is a network configured to wirelessly collect information collected from various sensors.It is wireless by identifying temperature, acceleration, location information, pressure, fingerprint, and gas obtained from the sensor. It is a network environment for real-time information transmission through the network. In this paper, zigbee wireless communication technology is applied to smart campus construction to support remote control, location-based service and real-time information sharing[3].

3. Design

3.1 Internal smart campus

The smart campus needs four core technologies. Terminal technology, network technology, platform technology, and service technology. Each field continues to develop along with the development of u-learning in universities, of which the sensor network field is the most active.

Looking at the development of smart campuses in Korea, in 1999, Sookmyung Women's University has built a “u-bi Sookmyung service” using mobile computing. The u-bi Sookmyung service supported electronic attendance, 2D barcodes and wireless network environments using mobile student IDs. Afterwards, the utopia research team at Yonsei University built a smart campus through mobile wireless network access such as color code-based u-profile, u-messaging, and u-campus tourguide services[4]. And based on Konkuk University's X Internet, which began in 2004, a comprehensive information system was implemented that applied the J2EE&EJB platform and CBD architecture development methodology, and Kyunghee University implemented the u-class by introducing the world's first “two-way lecture system”. In addition, Ewha Womans University is in the completion stage of ECC (Ewha Campus Center). After signing a memorandum of understanding (MOU) with SK Telecom on the construction of a smart campus, the USN system using u-library, laptop rental and information devices, and other parking systems, safety systems, and interactive lecture systems were expanded and implemented. The direction of u-campus in domestic universities is developing into platform development through intelligent mobile, multifunctional phone, sub-notebook PC, wearable PC, and information service through USN. However, these smart campuses are large universities and are not suitable for vocational

colleges. Therefore, in this paper, smart campus is designed in consideration of the characteristics of junior colleges[5].

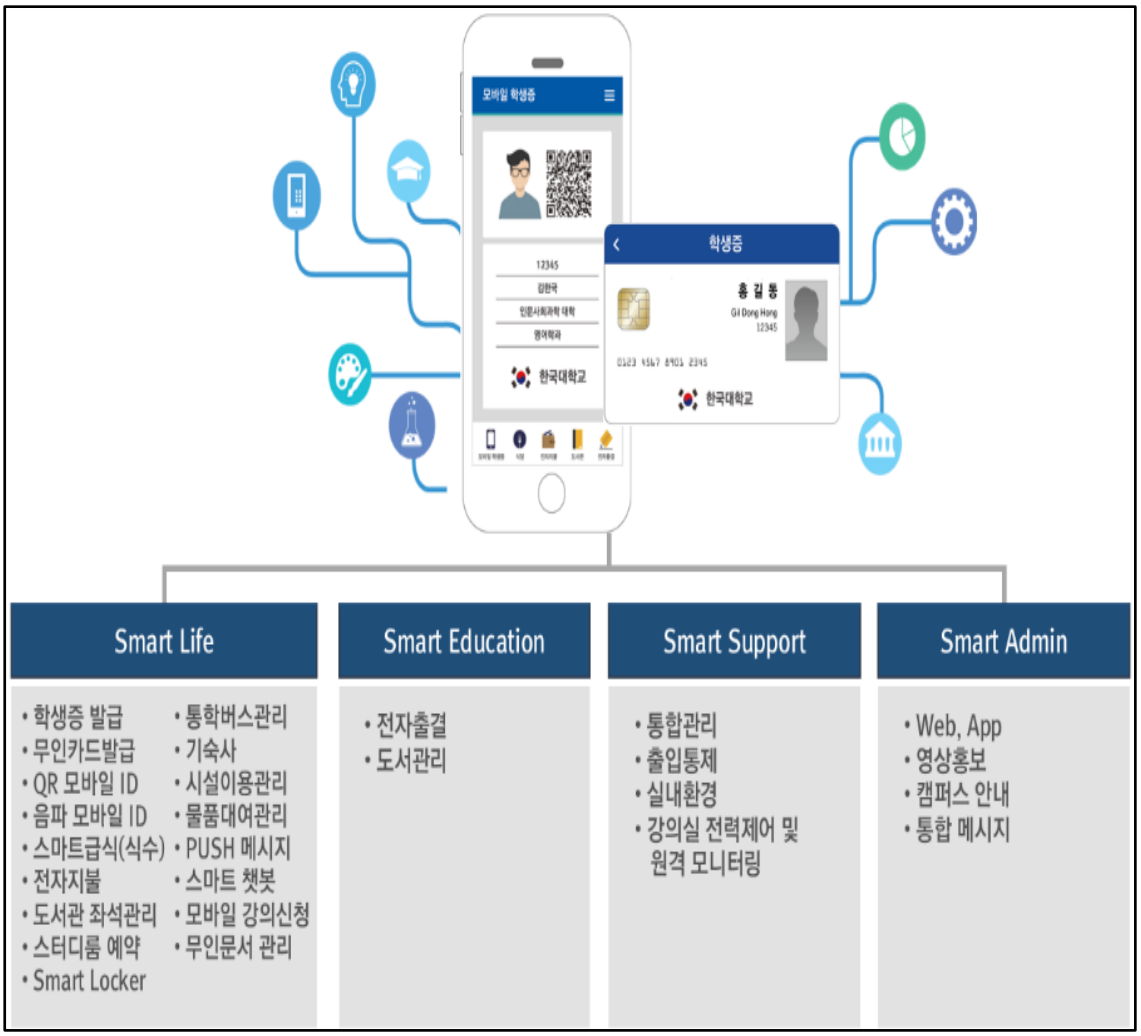

Figure 2. Yonsei University Smart Campus

Figure 2 shows the structure of the entire smart campus of Yonsei University. In addition to general functions, Yonsei University's smart campus provides various services such as electronic document-based administrative services[6].

3.2 International smart campus

Research and development of ubiquitous computing environment is making a lot of progress in foreign companies and related fields as well. In Japan, Tokushima University has developed a system (tango) that recognizes information of objects by attaching RFID tags to each object, and implemented a manner education system (JAPELAS) based on infrared data communication IrDA (Infrared Data Association) [7].

The University of Hannover (Germany) implemented a so-called “laptop university project” using notebook computers, mobiles and other information devices. The Georgia Institute of Technology (USA), called Georgia Tech, is promoting an e-class project called'classroom 2000'. e-Class implements a software infrastructure system environment that automatically saves and re-searches lecture contents using wireless LAN through an intelligent electronic board (Live Board) [8].

Figure 3. Structure of Hannover University

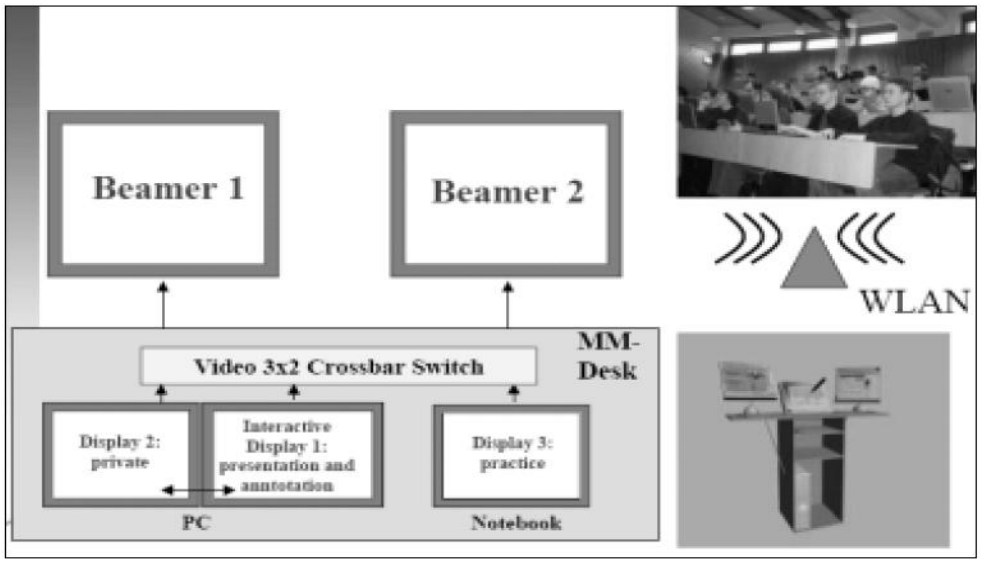

Figure 3 shows the system structure diagram of Hannover University, which has a well-established smart campus among overseas universities.

4. Smart campus service concept

4.1 Base design for realization of smart campus zigbee network

The universities that built each smart campus implemented an efficient ubiquitous environment through information transmission and retrieval through various network infrastructures. In this paper, we construct a smart campus using zigbee wireless communication suitable for low-cost, low-power, and low-speed sensor network environments considering the characteristics of junior colleges[9].

The design of this paper processes information by attaching and embedding a zigbee sensor module to an object or place necessary to implement a zigbee-based network to recognize the object and sense the surrounding environment of the installed place and transmit the data to the wireless network. do. For efficient sensing of the module, zigbee RF transceiver is installed by selecting a suitable location considering the communication efficiency

according to the location of the building and the location of indoor/outdoor building structures and equipment, and the OS is the OS for sensor network node suitable for large-scale network implementation. Suggest TinyOS. In order to speed up the sensor device response according to network initialization and to efficiently drive the zigbee stack, a kernel based on the Round Robin method is used rather than the Event Driven method. The chip is low-power, low-cost, supports 128-bit AES encryption method, uses JN5121 developed by Jennic, suitable for smart campus construction, and supports networking using CDMA network using CDMA module. Also, we propose efficient support by using korwin's KW-ZP-DUA1-JN3 for controlling the surrounding zigbee device through application programs such as PC or PDA[10].

4.2 Concept of smart campus using zigbee network

Figure 4 is the overall system design of the smart campus using zigbee network.

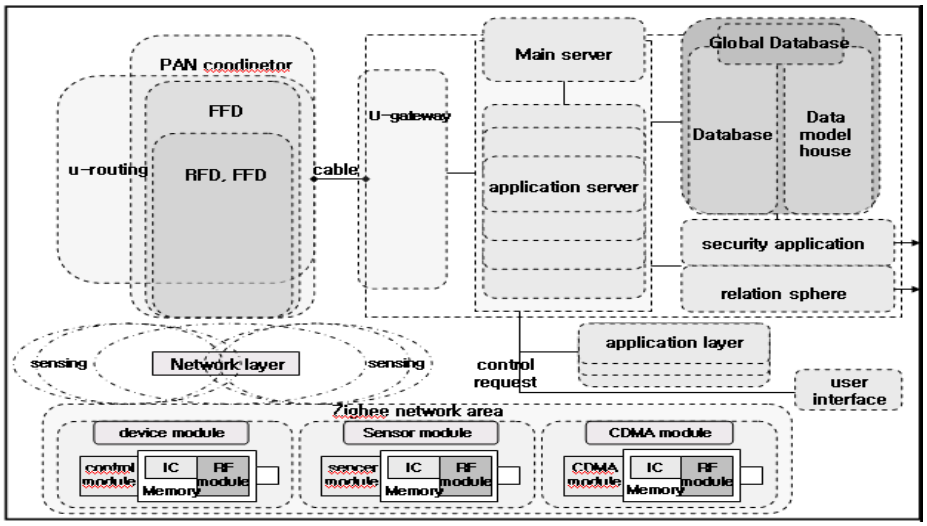

Figure 4. Entire system of smart campus using zigbee

Smart campus service based on USN infrastructure provides intelligent information service based on sensor network using zigbee chip in consideration of the characteristics of junior colleges[11].

Intelligent libraries, remote controls, and electronic bulletin boards provide authentication through user identification and information access using zigbee networking using electronic student IDs and zigbee modules attached to mobiles. In addition, through the sensing of the AP through the zigbee module, the electronic attendance function and the location search service of people and public facilities are supported, and a safe and efficient educational environment through environmental monitoring is provided through continuous environmental monitoring through an interface with a built-in S/W tool. Provided through appropriate control of the server. In addition, it provides a wireless network service that is complemented by zigbee's 128-bit AES for the security vulnerability of the wireless network in u-campus construction[12].

It recognizes the biometric information of students, professors, and faculty accumulated in real time from the sensing point, stores the activity amount in the database, and provides a health management service through the stored information. By transmitting continuous biometric information such as electrocardiogram and blood sugar to the server through mobile and electronic student ID with zigbee module attached and embedded by an individual, the transmitted information is stored and charted health records are provided through the user

interface. In addition, hospital-like health checkup tables can be provided from the server through the model house, and efficient health care services are provided to members by adding health abnormal warnings or regular checkup dates to the notification function[13].

The electronic library currently manages books by bar code recognition and manages the entry and exit, and has disadvantages such as non-contact or low recognition rate, and inability to track the location of books in real time. However, the zigbee network built using the zigbee module can search for major book locations using a real-time sensing system, and book reservations, specific pages, and downloads of relevant files using mobile. In the case of relatively large files, information can be provided using e-mail or personal web folder, and SMS text is provided for the completion of file transfer and additional book information[14].

Remote control services are provided for public equipment and major equipment in the school that are permitted to be used through the approval of the use of the server. Using the PC and mobile to which the control module is connected, it requests approval from the server through the zigbee network, and provides a remote control interface through the user interface when the server's approval is completed. The remote control service provides a level of control so that there is no disadvantage in the provision of convenience to the members, and supports the convenient activities of the members through the efficient remote control service[15].

The real-time electronic bulletin board using the zigbee network is used as a space for useful information such as message transmission through the network between students and faculty and student notifications on the electronic board, advertisements, and publicity anywhere in the school, and free transmission of frequently used document files and picture files. To support an efficient communication space.

In addition, through personal authentication through the member's mobile module and electronic student ID module, and access to the server and database using the zigbee network, a service that can be paid anywhere in the school is supported[16].

5. Smart campus service design

5.1 Intelligent library and electronic attendance service design

The intelligent library designed in this paper complements the problems in the existing bacode system and provides a convenient and efficient intelligent library service by applying a zigbee sensor network that transmits data through real-time sening[17].

When the existing bacobe system is used for a long time, the code recognition rate decreases and there is an inefficiency that a person must operate or monitor the reader to check the recognition. It also includes the disadvantages of the system where it is difficult to determine whether the bacobe is damaged. By complementing these shortcomings, it provides real-time book management and intelligent library services using zigbee network.

The intelligent library forms a zigbee network through books attached with the zigbee module and surrounding equipment. The intelligent library is composed of a mesh topology, and the data of the lower device is the upper device of each node and is transmitted through FFD, which serves as a routing. For optimized module sensing, an efficient location is selected based on the communication space where the AP is sealed, and a zigbee network is formed through multiple APs in consideration of the obstacles of the library[18].

The data of the book maintains a real-time network through sensing by the Round Robin method, and continuously checks the network status of the module. In the event of a failure, continuous sensing information to a specific module in the dormant mode is requested, and the sensing information is sent to the user interface. Through various monitoring of the server

using RS232c communication between the top stack of zigbee of the built-in S/W tool and the window application, it is possible to determine whether there is an abnormality and to perform quick maintenance[19].

The module attached book transmits location information to the server through continuous sensing of zigbee network and provides location information service through database access.

Figure 5 shows the service design of an intelligent library.

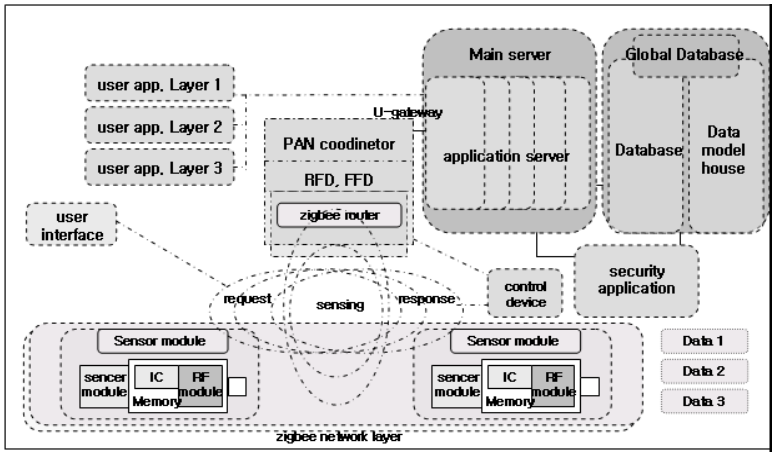

Figure 5. Intelligent library service design

The data of the book obtained from the module of the book is transmitted by the zigbee router, which acts as an AP, and forms RFD or FFD, which is a lower network through the adjacent book and equipment and zigbee module. The network topology of an intelligent library is formed by forming multiple networks through FFD or PAN codinetor between these sub-networks and another sub-network. The data is transmitted through the response of the lower FFD and RFD that is requested by the Contection Access Period method through the superframe mode from the zigbee PAN coodinator. After that, sensing information is transmitted to the adjacent FFD or upper device by receiving sensing confirmation and data transmitted through frequency by the response of a specific module that received a data request by the round robin method of the lower RFD and FFD[20].

Users are provided with convenient library use and services through intelligent libraries that provide services through this zigbee network. The intelligent library, which detects network access through the user's electronic student ID module or mobile module, verifies the user's identity through the server at the entrance of the library and allows access to the library. When an unauthorized user enters the library, a warning sound and a message suggesting use are displayed through a large LCD monitor installed at the entrance through a sensor installed at the entrance. In addition, when searching for a specific book, location search and book drafting and related information are provided only within the school, and page search and stored book information can be transmitted to mobile, e-mail and user web hard-disk through database access using zigbee network Do.

5.2 Health care service design

The health management service designed in this paper adds a module function that can measure biometric information to the zigbee module embedded in mobile and electronic student IDs, and provides health management information of members using biometric data continuously obtained through the zigbee network. do.

Figure 6 shows the transmission and utilization of biometric information data obtained through a member's mobile module.

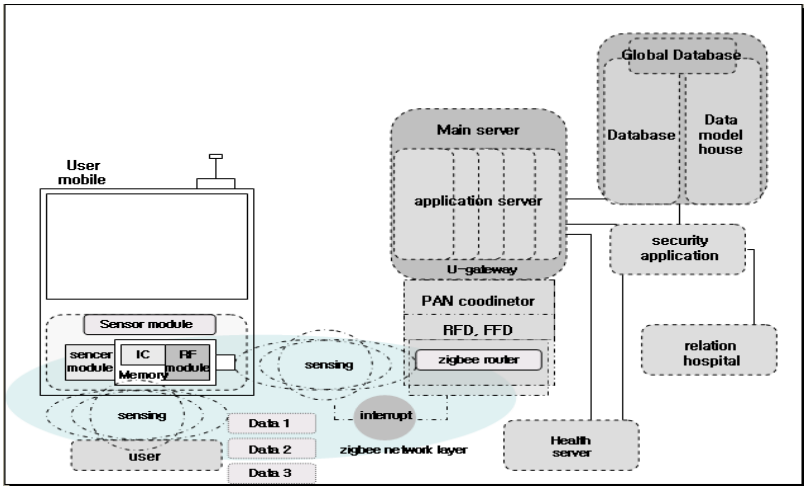

Figure 6. Health care service design

The user module transmits the request message for sensing through the zigbee RF transceiver located at the main campus location of the biometric information obtained from the user. The FFD of each network without a request based on the set period of time continues network sensing without a lock for sensing biometric information, and the FFD receiving the request locks all related sensing through zigbee RF transceiver and transmits biometric information. After giving priority to, the information is updated. The lock is released, the biometric information of the user module is sensed according to the reset sensing priority, and the sensor of the network is sensed according to the existing priority that has been converted to the dormant state.

The user's biometric information, which is continuously sensed and transmitted through the zigbee network, is transmitted to the back end server through the PAN coodinetor, and is stored in real-time in a health management-related database. The stored biometric information is transmitted to a dedicated management server through an agreement with a nearby university hospital.

In addition, it provides health information to users through continuous comparison with a database updated in real time by designing a disease-related data model by receiving various disease and health-related data information from university hospitals. Users can also receive their own health information through an interface that analyzes several charts through database access through authentication, and access to data model to support health management through self-diagnosis and provision of useful information.

In addition, if you connect to the health management server for daily exercise amount and target calorie consumption and set data through personal settings, you can receive exercise amount and calorie consumption for a certain time through SMS, and exercise method and recommended diet through related data are presented in a data model. It supports efficient health care services by providing them through the service.

Database health information stored for a certain period of time increases the reliability through the detailed examination of the related university hospital, and the detailed examination results are collectively transmitted through the e-mail of members. In addition, it minimizes the error of the data model through continuous updating of the data model, provides the user with an error rate of the data model, and increases the reliability to maximize the use of health information provided in real time.

5.3 Remote control service design

The remote control service designed in this paper builds a zigbee network between upper devices such as FFDs at major locations based on the lowest device set by embedding a zigbee module and zigbee AC control board for various equipments and major facilities in the campus. It is a service that provides a means to connect and receive useful database information accumulated from the outside, and to control a lower device through the topology regardless of the user's location.

It is possible to control various equipment and facilities connected to the surrounding zigbee network by using the control interface provided after receiving approval from the server through the zigbee network by using a zigbee cf card for zigbee control and a PC and mobile with zigbee usb dongle embedded. Do. During user access when requesting information for remote control, the module sends a remote control request through the upper node through the zigbee network, and during data loading time, the server checks the user's remote control possible level. When the user approves remote control, it transmits the user's information along with the user level message to the relevant server, and the remote control server creates a user hierarchy. The server responds to the approval result through the user interface and provides the following service after updating the database for the connection.

Possible control information according to the user's authority is coded and transmitted to the user module, and the code is encoded and displayed in the user interface. The user requests a possible control request to the server through the corresponding interface, and the control of the corresponding device is completed through the on/off function of the zigbee AC control board built in the relevant equipment and facilities according to the relevant control layer. Data sensing of control-related zigbee network is performed through update after re-priority of the control through interrupt generation and lock for related sensing, and transmission by fast data transmission method by Contection Access Period method of PAN coodinetor in superframe mode. do.

In addition, it supports unattended environment management by comparing data with environmental data set through continuous monitoring of environmental data. This can be applied to air conditioner, gas control, lighting system and temperature control, and additional zigbee module is built-in to enable efficient control and operation of related devices. Data sensing for all control is the same as the above control process.

The remote control service provides convenience through efficient control of peripheral devices, and provides the most suitable service for ubiquitous to members by providing wireless control in emergency situations or situations where direct control is difficult.

Figure 7 shows the structure of the remote control of an electronic device in which the device module of the zigbee network is built through the module built into the mobile.

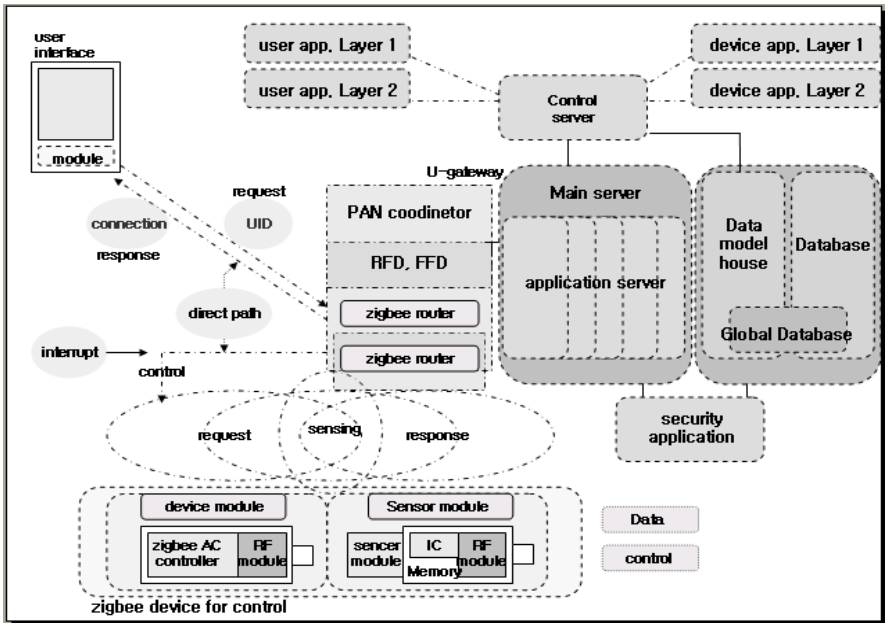

Figure 7. Remote control service system design

5.4 Other electronic bulletin boards and electronic payment services

As the need for communication spaces such as information exchange and file sharing among members has expanded due to the development of Internet and sharing services, an electronic space is needed only for members. In this paper, using the zigbee network, this paper provides a space for communication between members through network access through mobile and PC modules anytime, anywhere.

Using the zigbee CDMA module with built-in 2.4Ghz CDMA F/W and zigbee protocol stack, message transmission using CDMA network and free transmission only for files with relatively small file size such as document files and picture files with high utilization frequency. It is supported, and it is possible to use the electronic space of the electronic bulletin board through authentication through network access through the module. When request information for access is transmitted to FFD, FFD transmits the information to the upper node, and the server receiving the request information through the coodinetor performs authentication by encoding the module information of the user. Through authentication, an electronic bulletin board interface is provided through approval confirmation to the device, and the server transmits the module information to the relevant server to create a layer for the module accessing the bulletin board and provide information service.

By using this, free data transmission between members and using electronic boards support efficient electronic space through student notification, promotion, and sharing of useful information.

In addition, it is possible to access a payment-related server through access to the server through the zigbee network using the member's mobile module and electronic student ID module. It is possible to use it only after receiving authentication and embedding the certificate. When the server is accessed or sensing occurs in connection with payment, electronic payment is possible only when the password set by the user is transmitted to obtain approval. After approval, real-time updates are made through access to the database of the data, and using this, services that can be paid anywhere in the school are supported.

6. Conclusion and Future Works

In this paper, the sensor network environment of the smart campus was designed in consideration of the characteristics of junior colleges using zigbee wireless communication suitable for the construction of the USN environment. The smart campus service through the zigbee network provides a campus support system suitable for the introduction of a smart campus and efficient services in related fields. In addition, by comparing and analyzing the wireless network-based technology between universities that built a smart campus, it was shown that the smart campus construction of a sensor network environment using zigbee is the most suitable communication technology for the smart campus of a junior college. The future task obtained by writing this paper is: First, a study on the efficient coexistence of other wireless communication technologies in a smart campus environment that requires a variety of services. Second, it is necessary to find a plan for additional cost reduction in service implementation and application. Third, it is a complementary problem according to the network configuration of members. There is a 128-bit AES encryption process provided by the 802.15.4 standard, but a software complementary system must be implemented to supplement additional information.

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