Parking Management System Using ZigBee

Sangmi Shim , Seungwoo Park and Seunghong Hong

School of Electronic Engineering, Inha University Incheon, Korea

Summary

There are several ways to solve parking problem in the downtown One of them is to manage parking efficiently, that is, to raise use-efficiency of parking place and to help drivers to select easily. When we manage the parking place m the block efficiently, It can prevent disproportion that some parking space is over capacity and the other parking one is under. It causes not only the disproportion of economic efficiency but also the congestion of local road. The precondition to manage parking efficiently IS to analyse the parking characteristics.

In this study we found out the characteristics of parking vehicles by analyzing the turnover per parking mesh and occupancy rate And we build up total D/B by collecting every information about parking space. We developed the Parking Management System by using GIS with D/B and digital map. The efficient Parking Management System is for convenence of drivers and efficient usage of parking space. And this system is also the basic study to be developed as the total Parking Management System by upgrading every information [2][3]

Key words:

RFID, ZigBee, Sensor network, 802.15.4 LR-WPAN

1. Introduction

In this paper, Wireless Parking system using ZigBee that is a short distance wireless communication technology is examined. It is analyzed that RFID tag realization technology, radio protocol kit that uses a Zigbee's data sending out or receiving technology and ZigBee's software in TinyOS. Wireless communication technologies with RFID are Bluetooth, ZigBee, 802.11 xs, WLAN etc.[1]. The environment presented in paper is efficient parking management system that uses ZigBee so that is suitable in environment of dense Sensor network etc. The latest

Bluetooth or ZigBee is obtaining popularity by WBAN (Wireless Person Area Network) means of signal communication of distance within 1m and is expected to become the good alternative that can replace wire interface in sending out or receiving of RFID's sensing data. RFID and these communication elements compose Home networking and it checks various device states. And it also reacts upon with DB that can cause action and then may be used comprehensively for ubiquitous Home networking. RFID and ZigBee are expected to be used much in various applications at office in conjunction with existent Wired LAN and WLAN ofIEEE.802.11x type. The combination of this wireless communication and RFID is different from existent RFID (reader) services at fixed position. Devices that ZigBee attaches are expected to be miniaturized to removable size in future.[2]

In this paper, ubiquitous system that controls parking at company and outside WPAN environment is examined. It is possible to do wireless two ways communication between RFID reader and server using ZigBee by Kit and developed embedded software that acts in TinyOS and did potting. Designed system is consisted of Client part that combines DB-Server part ZigBee that contain information of tag. It sends to server using ZigBee communication and server analyzed information that received from each Client. Server sends information that and fits in each Client circumstance. Each Client can compose Ad Hoc network with connection medium of Access Point by having voluntary sending out or receiving equipment.[2][3]

2. Parking management System embodiment

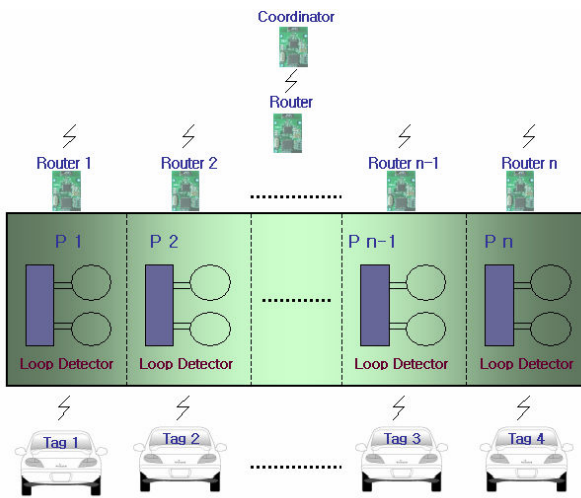### 2.1 An abstract of Parking management system

Figure 1.System block diagram

One of Zigbee's main characteristic is that network is possible. RFID or Bluetooth can not make many nodes because this kind of network is not supported. But, it is possible for Zigbee to do network such as Peer to Peer, Star, Tree, Mesh by several Topologies and if there a lot of parking areas, Zigbee can be performed easily. In this paper, an experiment of parking and evacuation using Tree Topology is examined. In Figure, Coordinator sends packet in PC through PC and RS-232 communication, or generates power to Application Program receiving packet from Router. Router accepts Tag's information at parking or evacuation time and transmits to Coordinator. Loop Detector examines the microscopic Loop Coil Inductance change amount that is produced by vehicles passing over loof coil sensor using 2 Loop Coil Sensors and grasps existence of vehicles. Because Tag has had user's ID within Zigbee board, it transmits ID to Coordinator at parking and evacuation time.[4]
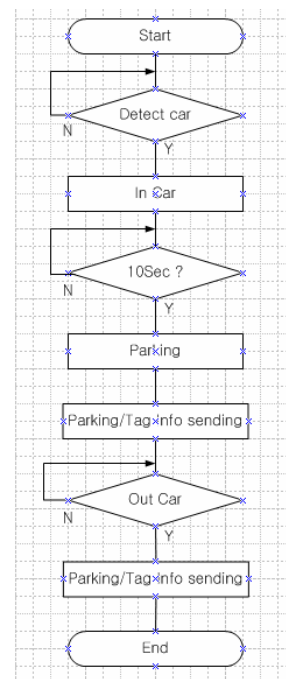

Figure 6. Parking flow chart

When cars were parked or not by Loop Detector's Induction that is checked, value of '0' of not parking and value of '1' of parking is delivered to GPIO of Zigbee (Router). So, it transmits to Coordinator with Tag's information that was parked if value of '1' is kept 10 seconds interval. At evacuation time, Loop Detector's value is delivered to Zigbee (Router) and is sent to packet by Coordinator if value changes from '0' to '1'. Sending out and receiving of all packets is generating messages of packet information and event to Application at parking and evacuation time. Parking management system embodiment in this study has long distance than other wireless communication so that communication is available in distance of 70 - 100 m in Open Space and it is profitable for big parking system embodiment because it can compose a lot of nodes in large parking lot.

3. ZigBee embodiment

3.1 ZigBee Abstract [3][4]

Concept called "Ubiquitous" means that "that is everywhere" which was introduced by Xerox's PARC (Palo Alto Research Center) in 1988 for the first time. This is the computing environment that all objects and target in physical environment become Intelligent and exchanges the information by linking each other. Specially, it is important that application of ubiquitous sensor network that computing targets are linked each other through sensor. It means that can manage own and adjoined essential factor and can use and manage efficiently this because it has electric power of battery form. We need new network protocol that can apply ubiquitous sensor network efficiently and standardization work of IEEE 802.15 WPAN is under the process. This is the reason why this study wishes to investigate about parking management system that using 802.15.4 LR-WPAN that is suitable for s to ubiquitous sensor network in application of sending out and receiving small amount of data.[4][5]

Recently, ZigBee technology has risen newly focusing on personal wireless communication technology of low speed, low-cost, low electric power. ZigBee that from upper network based on PHY of IEEE 802.15.4 LR (Low Rate)-WPAN   and MAC to application service is developed in ZigBee association of nonprofit organization according to environment of application. ZigBee that has these low speed, a low-cost, low electric power consumption completed the standard of PHY and MAC class in IEEE 802.15 .4. ZigBee is slower than Bluetooth that is a personal wireless mobile communication technology with 2.4GHz and 250 Kbps rate. I is called low speed version of Bluetooth on this account. This technology designs to minimize electric power exhaustion to overcome low speed. In the case of ZigBee consumes same electric power as Bluetooth, communication distance can be expanded far more and price is inexpensive. It aims to be used at all information appliances at family and office as low-cost, low speed personal communication technology and it will react between wire and wireless network by composing wireless piconet, ad hoc scatternet etc.. Therefore, if wireless network is completed using

Zigbee, there will be free data swapping between all information appliance (specially, Home gateway, notebook, PDA, personal communication terminal, information electronic etc). If compose Internet bridge, internet information that can reach user's hand for the first time by reaching desk top computer through fiber-optic cable or ADSL, modem etc... It can be seen as completion of ultimate target of wireless communication that anybody can exchange information anywhere and anytime.[5]

3.2 ZigBee Board Spec.

Figure 2. ZigBee Block Diagram

 Characteristic by each Block of Figure 2 is as following.

3.2.1 MCU

  - In the case of Coordinator or Route, use ATMega128L that has big capacity to perform by FFD. (Full Fuction Device)

ISP / JTAG : Use compiled *.hex or *.eep files to up/download

Debug of JTAG is possible to*.cof file.

- RS - 232 use for communication with PC.

-   SPI communication use to exchange data with CC2420.

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3.2.2 CC2420 [6]

  . True single-chip 2.4GHz IEEE 802.15.4 compliant RF transceiver with baseband modem and MAC support

. DSSS baseband modem with 2 MChips/s and 250 kbps effective data rate.

. Suitable for both RFD and FFD operation

. Low current consumption (RX: 19.7 mA, TX: 17.4 mA)

. Low supply voltage (2.1 ~ 3.6 V) with integrated voltage regulator

. Low supply voltage (1.6 ~ 2.0 V) with external voltage regulator

. Programmable output power

. 128 (RX) + 128 (TX) byte data buffering

. Digital RSSI / LQI support

. Hardware MAC encryption (AES-128)

. Battery monitor

Actual state of Block Diagram in Figure 2 above is same ZigBee Board of Figure 7.

3.3 Antenna

Reflection by impedance difference is minimized by impedance matching (50 ohms) between CC2420 and antenna connection and tuning material of antenna by FR4 has lower permittivity than ceramics that secures better performance.[6][7]
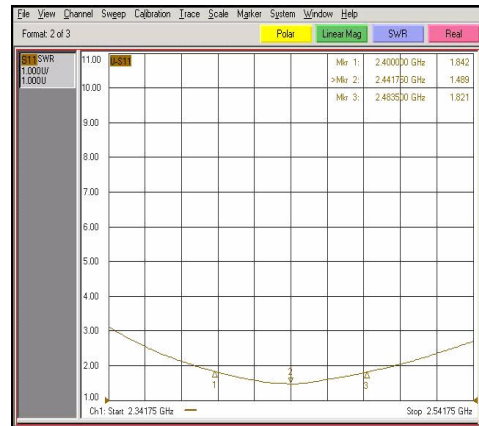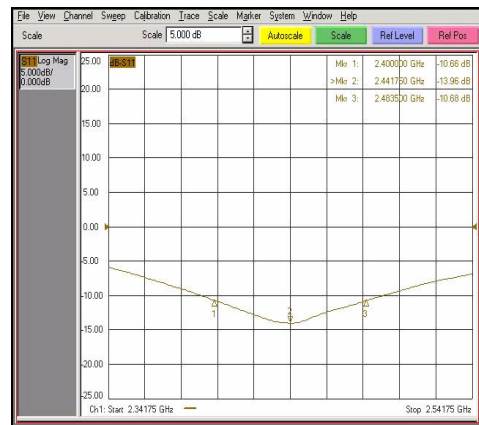
Table 1. Electrical Specifications

Frequency Range (MHz)	2400 2483.5
Band Width (MHz)	83.5
VSWR (Min)	1.9 : 1
Gain (Max)	2 ± 1 (dBi)
Input Impedance	50 (Ω)
Polarization	Linear

Figure 3. VSWR

Figure 4. Return Loss

Table 2. Conversion table VSWR / Return Loss

Performance	VSWR	Return Loss (dB)
	1.01	-46.1
Better	1.05	-32.3
	1.4	-15.6
	1.5	-14.0
	1.75	-11.3
Good	2.0	-9.5
	...	...
	3.01	-6.0
	...	...
	5.85	-3.0
Worse	8.72	-2.0
	17.4	-1.0

As seen in Figure 3, 4 and Table 2 above, value 2.0:1of VSWR 2.0 same as power absorption of 90% is very good quality of antenna. In the case of 3.0:1, it has power absorption of 75% and special quality is worse than 2.0:1. As value of VSWR is smaller, reflection of power is low, absorption of power is big and antenna performance is improved. If Return loss is about -10 dBs, VSWR becomes under 2:1 and input matching goes well relatively. If Return loss is about -14 dBs, VSWR becomes under 1.5:1 and input matching goes almost perfect.[4][5][6]

3.4 ZigBee Protocol Stack

ZigBee provides a small footprint protocol stack providing the following features: [6]
. IEEE 802.15.4 MAC/PHY
. Networking Layer providing ad hoc, self forming network connections and self-discovered network routing
. Application Layer providing message exchange standards and industry specific profiles.
. Security using AES-128 and key management at MAC, network and application layers.
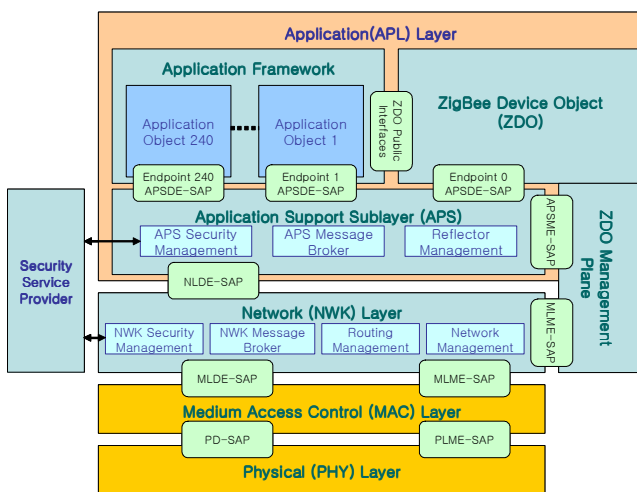The ZigBee protocol stack is as shown in Figure 5.

Figure 5. ZigBee Protocol Stack

3.4.1 Network Layer

The ZigBee protocol stack is comprised of the following layers as shown in Figure 5:
. Network (NWK) Layer - The Network Layer performs the following functions:
  o Supports a packet frame employing data and command packets.
  o Supports hop by hop routing of packets in one of two routing modes:
    - Tree routing - Packets destined for other devices in the network are routed to parent or child devices based on the network formed via IEEE 802.15.4 associations and the network address of the destination. [7]
    - Table routing - A previous route discovery cycle is utilized where the destination has been reached via broadcast messages and unicast responses have recorded the path from source to destination via table entries at each hop.

3.4.2 MAC Layer

The ZigBee protocol stack operates overtop an IEEE 802.15.4 MAC. Specifically, the following layer interfaces within ZigBee/IEEE 802.15.4 are supported:[3] [7][8]
. IEEE 802.15.4 MAC (MLDE-SAP and MLME-SAP) to ZigBee Network (NWK) layer
  o The MLDE-SAP provides the following services:
    .. Data request, confirm and indication
    .. Purge request and confirm
  o The MLME-SAP provides the following services
    .. Association request, confirm, indication and response
    .. Disassociation request, confirm and indication
    .. Beacon Notify indication
    .. Get request and confirm
    .. Set request and confirm
    .. Orphan indication and response
    .. Reset request and confirm
    .. Receiver enable request and confirm
    .. Scan request and confirm
    .. Communication status indication
    .. Start (network) request and confirm
    .. Synchronization request
    .. Synchronization loss indication
    .. Poll request and confirm

4. Experiment environment

In this study Application generates packet and message using Visual C++ 6.0 based on Windows 2000 Professional OS, Stack to run Zigbee is Z-Stack CC-1.0 which was offered by Chipcon. WinAVR-20040720 is used as the compiler.
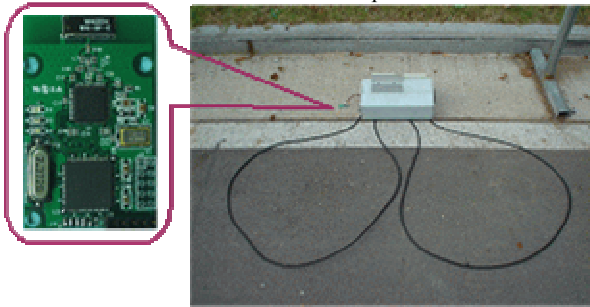

Figure 7. Actual measurement environment

Zigbee's Board Size is 42mm*27mm and RS-232 Baudrate between Coordinator and PC is 38400bps.

Figure 8. Application

5. Result

This paper examined RFID's abstract and principles of structure and performance based on existing parking management system and presented application plan that was combined by ZigBee's technology. ZigBee is extensively discussed in several fields as network and perception technology is recognized. [3][4]Although there are many RFID studies, example or theoretical data, it can make new effect in application field by reacting with wireless communication technology such as ZigBee. In this paper, new parking management system was introduced combining with ZigBee. This paper has error range in different environment on proximity problem of correctness. Study in the future has to develop new environment and communication program reacting with position realization by camera in area that accuracy rate drops in realization. Also, when is used with technology of BAN, WPAN, WLAN etc., development of related installation has to be achieved together.[8][9][10]

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Sang mi Shim received the B.S. degree in Computer Engineering from Konyang University, Daejeon, Korea, in 1996. and the M.S. degree in Electronic Engineering from School of Electronic Engineering from Inha University, Incheon, Korea, in 1999. She has been received the Ph.D. course in Electronic Engineering at the School of Electronic Engineering from Inha University, Incheon, Korea from 2001. Her main research interests are in the areas of biomedical signal processing, healthcare system and various industrial applications.
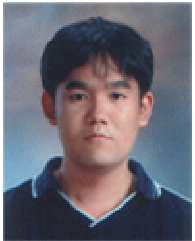
Seung woo Park received the B.S. degree in Electronic Engineering from Honam University, Gwangju, Korea, in 2002. and the M.S. degree in Electronic Engineering from School of Electronic Engineering from Inha University, Incheon, Korea in 2004. He has been received the Ph.D. course in Electronic Engineering at the School of Electronic Engineering from Inha University, Incheon, Korea from 2004. His main research interests are in the areas of medical image processing, radiation instrument and biomedical signal processing.

Seung hong Hong received the B.S. degree in Electrical Engineering from Inha University in 1963. He received the M.S. degree in Electrical Engineering from Inha University in 1966, and the Ph.D. degree at the School of Biomedical Engineering from Tokyo University, Japan in 1975, respectively. He was a director and chairman at the Institute of Electronic Engineer of Korea from 1981 to 1994. He was a director, vice chairman, and chairman at the IEEE Korea Section from 1983 to 1997. He has been with the Department of Electronics Engineering at In-ha University. His main research interests are in the areas of bio-signal processing, rehabilitation engineering, medical image processing.