

Design of RSSI Signal Based Transmit-Receiving Device for Preventing from Wasting Electric Power of Transmit in Sensor Network

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Abstract

In WPAN environment using the existing ZigBee communication, the determination of transmitting electric power output of sensor is set up at the early stage which composes system. Therefore, the devices which compose WPAN use the way to transmit with the output value that is set as fixed irrelevantly to the distance of other device and it causes excessive electric power for transmitting. As a result, the life-expectancy of battery is reduced and there happens interference among devices. So, in this paper, a transmit-receiving system which can transmit signal using proper electric power for transmit to other device that transmits signal by the receiving intensity of measured signal after measuring intensity of RSSI of each device for solving interruption problem among device and wasting electric power transmitting.

Keywords: WPAN, WLAN, ZigBee communication, RSSI, WSN, Low Power Trasmitt

1. Introduction

Wireless sensor network in recent years is a technique with rapid development and it provides mobility and flexibility. Also it is easy to compose of active network, distribute, and has low cost. Wireless sensor network provides low electric power consumption with loosening the condition of demanded throughput for industrial field, vehicle, sensors in home, and etc. And it tries to do a wireless networking with low cost by a simple wireless connection to device level communication[1].

As wireless sensor network is developed, WPAN(Wireless Personal Area Network) appeared because of demand for the close range wireless communication through the development of computer-related technique and information and communication technique, and another demand for wireless based communication among various and different devices. And the device like WPAN which is used in wireless sensor network appeared because of the

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necessity of small, low power, low price, environment friendly transmitting method. The form of WPAN is composed of 60GHz WPAN, WiMedia UWB, Mobile bluetooth, ZigBee telecom application, smart grid, low speed WPAN, and etc.

WPAN makes communication available with devices like computer which is away, peripheral, cell-phone, and appliances. And it connects with each devices wirelessly and uses wireless communication method like ZigBee, Bluetooth, UWB(Ultra Wide Band). The devices which composes WPAN consists of various sensors that detect temperature, humidity, vibration, illuminance and etc, and remote control/surveillance module. It doesn't use normal electric power like AC 110~220V but small battery. Therefore, the electric power of device which composes WPAN is required to reduce electric power consumption to guarantee electric power for years or months.

So, in this paper, the transmit-receiving system which can transmit signal by proper electric power to other device that receives the signal by the receiving intensity of being estimated signal and measure the intensity of Received Signal Strength Indication(RSSI) which each devices receive to solve a problem of interference among devices and wasting electric power is proposed.

This paper consists of: Chapter 2 analyses the technique that increases energy efficiency and outline of wireless sensor network. Chapter 3 proposes the technique that guarantees scalability of network maximizing energy efficiency of wireless sensor network. Chapter 4 analyzes and evaluates the efficiency of proposed framework. At last, chapter 5 describes further research direction related with the result.

2. Related Research

2.1 Wireless Sensor Network

Though wireless sensor network is studied and used as a method of military surveillance and trace, recent application field is used in the field of environment/ecology surveillance, energy management, distribution/stock management, and medical monitoring. It is now researched variously about wireless sensor network in various and widespread field[2].

The composition form of wireless sensor network includes various different sensors, and in the case of some sensors' stop it doesn't affect to whole network. And it has an attribute that is free to distribution allocation. And wireless sensor network has problems like low transmit speed of device, transmit error, impossibility of exchange of sensor node and restricted electric supply[3]. The most important element of wireless sensor network is reducing electric power consumption which is used to deliver data because sensor nodes that activate by small battery are distributed to certain region randomly and it transmits information as much as the capacity of battery.

It is important to design protocol suit for the condition that reduces power consumption of sensor nodes in wireless sensor network. The existing research technique on wireless sensor network is focused on the composition of network and mobility of nodes and it is proposed mostly with MAC(Multiple Access Control) and routing protocol to increase the energy efficiency of sensor node[4]. Because wireless sensor network is a cooperation system of sensor nodes, for the energy efficiency a technique which maximizes scalability of network and life-expectancy of whole network that is consisted of a lot of nodes, and also extends lifespan of each nodes which consist of sensor network when MAC(Multiple Access Control) and routing protocol are designed.

2.2 WPAN and WLAN

Nowadays, in the field of personal wireless networking solution, WPAN(Wireless Personal Area Networks) technique which is used at close range as long as 10m is getting attention while being compared with the existing wired networking technique. WAPN has a convenience that avoids cumbersomeness that connects several devices with cable, performs data communication wirelessly at the distance of 0~50m, and includes the element technology which interlocks sensor and gateway, and sensor and sensor like Bluetooth, ZigBee, UWB(Ultra Wide Band), and etc. WPAN is for the wireless connection among personal-centered small peripherals and its purpose is distinguished to WLAN[5].

WLAN(Wireless Local Area Network) is network which accesses from computer to Access Point wirelessly instead of LAN Cable. Wireless LAN makes devices in the restricted area communicate to each other. Therefore the user can access to network while walking around the area of wireless LAN. WLAN is highly secured but its protocol standard is complicated. The radiowave interference is severe. And it consumes electric power very much so it has to be replaced often. Table 1 compares the specification of WPAN and WLAN.

Table 1. Comparison Table for Specification of WPAN Between WLAN

	WLAN		WPAN		
	WLAN11b	WLAN11n	Bluetooth	ZigBee	UWB
IEEE Standard	IEEE802.11b	IEEE802.11n	IEEE802.15.1	IEEE802.15.4	IEEE802.15.3
Frequency Band	2.4GHZ	5GHZ	2.4GHZ	915M/2.4GHZ	3.1~10.6GHZ
Transfer Rate	11Mbps	500Mbps	1Mbps	40/250Kbps	54Mbps
Communication Distance	50m	1Km	10m	30m	2~10m
Features	Data Transmission	Data Transmission	Support Various Communications(Voice, Fax)	Low Price/Power Transmit Stability	High Speed Strong at Interference
Applications	PC	PC, Mobile	Wire Substitution of ShortRange	Control of Low Power/Price Device	Short Range High Speed Communication

WPAN is recognized as a key technology which consists of ubiquitous sensor network in the environment of next generation digital home and constructs massive ubiquitous network connected existing WLAN or CDMA network. Like this, WPAN is expected to do an important roll in local area wireless technique business and this various applications which can be adapted to WPAN should be developed to vitalize.

2.3 Overview of THE 802.15.4 Based ZigBee

ZigBee is one of IEEE 802.15.4 standard which supports close-range communication and it is a technique for close range(10~20m) communication and ubiquitous computing in the field of wireless networking in home and office as a concept of mobile phone or wireless LAN. Compare to existing technique, it transmits small amount of information instead of minimizing electric power. It is a form of dual PHY and uses frequency band of 2.4GHz, 868/915MHz. Its modem method is direct sequence spread spectrum(DS-SS) and the data transmit rate is 20~250kbps[6].

ZigBee based QPAN is a close range wireless communication standard which features low coverage, low rate communication, low cost, and low power. And it is the technique that consumes low electric power, has inexpensive chip, and has high stability of communication. ZigBee is suitable for remote control, management, and monitoring. It creates demands in the field of factory and home automation, healthcare, and home network by applying other IT technology like finger print, voice, and biometric.

In the future, support of ubiquitous networking environment is necessary and for these function it is the most important to realize sensor networking technique. Though ZigBee technology has low data transmit rate, it will be widened in the business of low power consumption WPAN(specially in the field of automatic control) because it connects a lot of nodes for surveillance and control also it is good at using low power comparing to other techniques. Specially it is expected it will be the best suitable technique to ubiquitous environment because it consumes power less and the chip cost is lower than Bluetooth, UWB.

3. Design of RSSI Signal Based Transmit-Receiving Device

This paper transmits a data with fixed output value which is set up as irrelevant to the distance of other device in the existing the existing WPAN environment using excessive transmit electric power. Therefore it shortens the lifespan of battery and happens interference among sensors. To solve these problems, this paper proposes low power transmit method which reduces electric power consumption by controlling transmit power as the receiving strength of each sensors.

3.1 Components of WPAN for Low Power Transmit-Receiving System

WPAN represents ZigBee network and composes wireless network with form of tree by distributing coordinator(C), router(R), end device(T) to defined CELL. Coordinator manages several router, and collects data by several end device. Figure 1 shows the structure of defined CELL which composes WPAN.

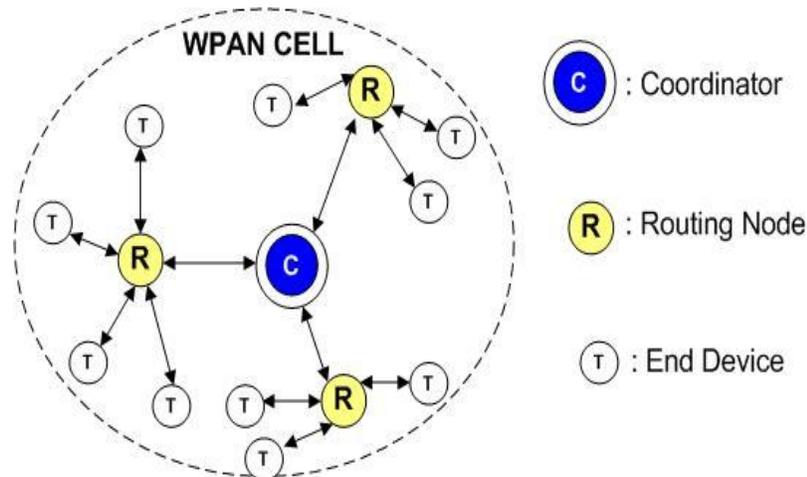


Fig. 1. Structure of WPAN CELL

Coordinator saves the information that is transmitted by router and end device. Router engages data communication of coordinator and end device, and data communication of end devices(ED). End device(ED) requests network access by coordinator directly or via router. And when it is accessed through coordinator, it transmits and receives data packet from and to

other end device via coordinator or router. Devices that compose WPAN include coordinator, router, and end device(ED). Each devices transmits data after properly setting the transmitting output by transmit distance, radio environment, and RSSI(Received Signal Strength Indication). Through this, each device reduces electric power consumption by preventing unnecessary electric power consumption when transmits data.

3.2 Receiving Module Functin and the Structure of Device Composing WPAN

Coordinator, Router, and End Device that compose WPAN has same basic structure including antenna and antenna related devices. Each device is consists of signal receiving module, signal transmit module, and transmit electric power controller. Figure 2 shows the structure of device that consists of WPAN.

The receiving part of device consists of signal receiving module with antenna, receiving signal processor, Analog to Digital Converter(ADC), digital signal processing module, and RSSI making module. The received signal through antenna is amplified by amplificator, and after performs frequency transfer operation on I channel signal and Q channel signal by receiving signal processing module it print out received data which is processed by digital signal processing module to RSSI making module after transferring into digital data by Analog Digital to Converter(ADC). Digital signal processing module prints out after rewarding frequency deviation of received data as much as 80ppm to keep the receiving capacity. RSSI making module saves the calculated RSSI value to register after calculating signal level of related channel receiving data among channels(received data from digital signal processing module). And RSSI making module makes transmit electric power controller adjust transmit power of electric power amplificator based on RSSI value of received signal by printing out the saved RSSI value to transmit electric power controller.

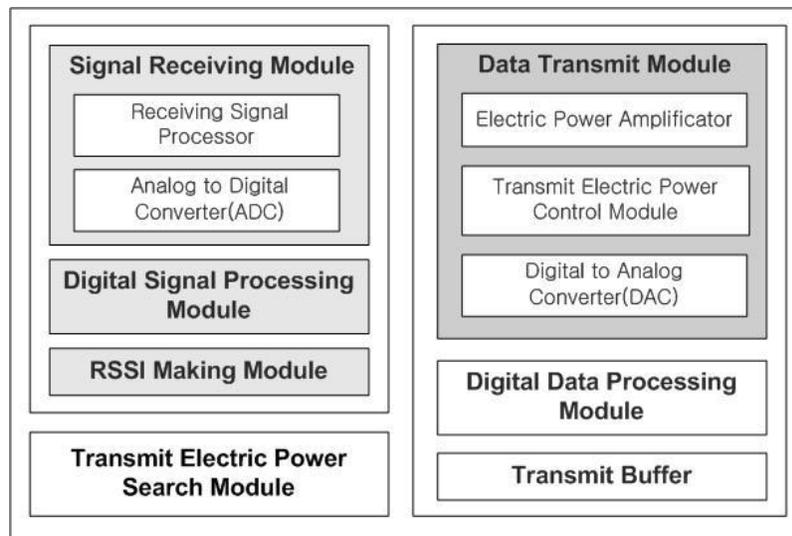


Fig. 2. Structure of Device Composing WPAN

3.3 Transmit Module Function of Device Composing WPAN

The transmit apparatus of device basically has transmit buffer and processes data of transmit buffer. And then it play a roll which transmit digital data that is saved in transmit buffer after transferring it into analog signal on the contrary. The compositions of transmit

module are digital data processing module connected to transmit buffer, Digital to Analog Converter(DAC), transmit electric power control module, electric power amplifier, and antenna.

Digital data processing module spreads data for message transmitting which saved in transmit buffer after being created using PN code which is 32chip spread sequence which is proposed by IEEE802.15.4 mapping mapping as four bit simbol unit after transferring into source data and by automatical creating and adding of Preamble and Frame Start. In this part, spread sequence chip rate is 2Mcps and 16 symbols of 4bit simbol0(0000b)~F(1111b) are allocated 32bit PN code. And 32bit PN code is separated into I(In Phase) channel and Q(Quadrature Phase) channel, and it creates Half Sine which is proposed by IEEE802.15.4

Digital to Analog Converter(DAC) transfers created Half Sine pulse into analog signal through DAC. Transmit electric power control module gets rid of noise which exists in analog signal and performs frequency upper change. Electric power amplifier amplifies transmit data by electric power setting value if transmit output controller. Transmit data which is amplified is transmitted other device through antenna. Then, transmit output controller prevents waste of excessive transmit electric power because it adjusts electric power amplifier properly by setting transmit electric power by RSSI signal from receiver.

3.4 Function of Transmit Electric Power Search Module

To solve the problem of wasting transmit electric power in each device which composes WPAN environment, transmit electric power requires proper management. Therefore, in this paper, coordinator, router(R), and end device that compose WPAN(ZigBee network) save detected transmit electric power value into transmit electric power management table after searching transmit electric power for each device to manage transmit electric power. The work which transmit electric power search module performs to calculate proper transmit electric power value is like the algorithm below.

Algorithm: The method to calculate transmit electric power value

- 1) Receive data packet from opponent device which wants data transferring.
- 2) RSSI making module of signal receiving module saves RSSI value to register after calculating it from receiving data.
- 3) Data transmit module decides transmit electric power from saved RSSI value.
- 4) Transmit electric power should be adjusted to be the level of -70~85dBm as a normal data transmit-receiving standard level and then transmitted.
- 5) Request receiving RSSI value to opponent device by using adjusted transmit electric power to confirm that opponent device receives transmit electric power properly.
- 6) Detect RSSI value from received packet if the requested answer from opponent device is received.
- 7) Save decided transmit electric power value as the transmit electric power value of opponent device to electric power management table and end transmit electric power researching procedure if the detected RSSI value is in the normal range.
- 8) Repeat transmit electric power researching procedure until finding transmit electric power which is in normal range if the detected RSSI value is out of normal range.

4. Conclusion

RSSI signal based transmit-receiving device to prevent from wasting proposed transmit electric power uses RSSI value of receiving data like the proposed algorithm and searches proper transmit output for each device in network, calculates it, and saves it to transmit electric power management table. And it prevents from excessive transmit electric power by control transmit output according to frequency environment and control transmit distance and receiving intensity according to opponent device using saved transmit electric power value. And while network is being updated, transmit electric power management table can be updated by detected transmit electric power value which is searched proper transmit electric power on each device again using the proposed algorithm.

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