Part Number: CFP16C03-ART
ISBN : 978-1-5090-0744-8

ICCEREC

The International Conference on Control, Electronics, Renewable Energy, and Communications 2016

CONFERENCE PROCEEDINGS

13-15 September 2016, Grand Royal Panghegar Hotel, Bandung - Indonesia

Sponsored by

IEEE ComSoc
IEEE Communications Society
Indonesia Chapter

Organized by

Fakultas Teknik Elektro
School of Electrical Engineering
Telkom University

2016 International Conference on Control, Electronics, Renewable Energy, and Communications (ICCEREC)

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WELCOME MESSAGE FROM THE CONFERENCE CHAIR

Dearest Scientists, Engineers, Colleagues, Ladies and Gentlemen,

It is our great pleasure and honor to welcome you to ICCEREC 2016, The 2nd International Conference on Control, Electronics, Renewable Energy, and Communications and also to our beautiful Bandung. This city was nicknamed “City of Flowers“ and “Paris Van Java” ("*The Paris of Java*").

ICCEREC 2016 is organized by School of Electrical Engineering Telkom University and technical co-sponsored by the IEEE Communications Society Chapter Indonesia, so that ICCEREC has a strong foundation of bringing together industry and academia.

This conference provides an international forum for researchers, academicians, professionals, and students from various engineering fields and with cross-disciplinary interests in ***Control and Automation, Electronics, Renewable Energy, and Communications***.

Accepted papers on ICCEREC 2016 are published in the ICCEREC 2016 Conference Proceedings and presented papers will be submitted to **IEEE Xplore**. As information, the Proceedings of ICCEREC 2015 has been published in **IEEE Xplore** and indexed by **SCOPUS**.

In this moment, I would like to thank, all those who have contributed to the success of ICCEREC 2016, such as Organizing Committee from School of Electrical Engineering Telkom University, IEEE Communications Society Chapter Indonesia. We also say thank you to the TPC Chair, the TPC Members, the Keynote Speakers, Tutor Speaker and the Technical-sessions Moderator of ICCEREC 2016.

The last, we hope all participants will have valuable and also enjoyable experience during this event and very pleasant stay at Bandung.

Sincerely Yours,

General Chair

Muhammad Nasrun
Telkom University

WELCOME MESSAGE FROM TPC CHAIR

Dear Ladies and Gentlemen,

On behalf of the ICCEREC 2016 Technical Program Committee, we are very delighted to welcome you to the 2nd edition of International Conference on Control, Electronics, Renewable Energy, and Communications (ICCEREC 2016), in Bandung, Indonesia. Located right in the middle of West Java, Bandung is a beautiful, multi-cultural and multi-ethnic city, and the temperature is mildly warm. Modern buildings intertwined with colonial architecture, parks with full of color, streets, markets, mosques, and houses mingle in an exotic blend, which are active during the day and night.

In this conference, we are trying hard to make a high quality technical committee that will feature three plenary talks to enlighten the audience with world-class speakers on the latest topics on Signal Processing, Renewable Energy and Telecommunications, tutorial sessions presenting hot topics on several subjects, and technical sessions with high quality papers. We set a high standard for a paper, that each paper should have been reviewed by minimum 4 international reviewers. Our professional team is committed to establishing a conference for sharing the latest technical/research advancements. In addition, the conference will also feature with the launching of a new Indonesian Chapter of IEEE Signal Processing Society.

We would like to thank all the authors who submitted their papers to ICCEREC 2016. It is our pleasure to know that you will appreciate the high quality and wide variety of the ICCEREC 2016 technical programs, have fruitful discussions with other researchers, and enjoy the beautiful venue. We would like to express our sincere appreciation to the Technical Program Committee members and paper reviewers for their great work in shaping the technical program and handling the paper review process. The TPC particularly wish to thank the organizing committee colleagues. You have all helped to create a technical program of the greatest interest. We hope you all enjoy it!

Sincerely Yours,

TPC Chair,

Dr. Ing. Fiky Yosef Suratman
Telkom University

PROGRAM AT A GLANCE

Day One: Tuesday, 13 September 2016

TIME	AMARTAPURA C	MADHUKARA A	AYODYA C
07.00 - 08.30	Table Registration		
08.30 - 08.45	Opening Speech		
08.45 - 09.00	Speech from the Chair of ICCEREC and APWiMob		
09.00 - 09.15	Launching IEEE SPS Indonesia Chapter		
09.15 - 10.00	Keynote Session I		
10.00 - 10.30	Coffee Break & Photo Session		
10.30 - 11.15	Keynote Session II		
11.15 - 12.00	Keynote Session III		
12.00 - 13.00	Lunch Break		
13.00 - 15.00		Tutorial Session I	Technical Session I
15.00 - 15.15		Coffee Break	Coffee Break
15.15 - 17.00		Tutorial Session II	Technical Session II

Day Two: Wednesday, 14 September 2016

TIME	MADHUKARA A	AYODYA C	AYODYA D
08.00 - 09.30	Tutorial Session III	Technical Session III	Technical Session IV
09.30 - 09.45	Coffee Break	Coffee Break	Coffee Break
09.45 - 11.00	SPS (Signal Processing Society) Indonesia Chapter 1st Meeting	Technical Session V	Technical Session VI

A Multiuser Vital Sign Monitoring System Using ZigBee Wireless Sensor Network

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Abstract—**This paper discussed one of ZigBee application as data transmission media for patient's vital sign monitoring. The ECG signal, heart rate, temperature, and blood pressure are taken from patient's body by the vital sign monitoring device (MGW830), and then raw data is sent serially by ZigBee to two computers as monitoring device wirelessly. Furthermore, the data can be accessed by other authorized parties via monitoring devices for the purpose of monitoring. By using this application, patient's vital sign can be seen remotely.**

Keywords— ZigBee, Vital Sign Monitoring, ECG, wireless sensor network

I. Introduction

Development of telecommunication technology increase rapidly and widely used to support applications in the medical application. One of the technologies which are support telemedicine is wireless sensor network (WSN) for a vital signal monitoring system. Several WSN platforms have been developed such as ZigBee for practical applications. ZigBee protocol supports the unique needs of low-cost and low-power wireless sensor networks [1].

Vital Signs are measurements of the body's signal which is represent the most basic function of body [2]. The four main vital signs routinely monitored by medical professional are body temperature, pulse rate, blood pressure, and respiration rate. Vital sign monitoring is used for the patient who requires periodic and continuous monitoring.

Research by Rashid et.al has made an ECG monitoring system based WBSN and the majority focus on the development of a remote Wireless Biomedical Sensor Network, named Telekom Research Group (TRG) remote. The system complies with IEEE802.15.4 standard and operates in 2.4 GHz ISM band [3]. Hardware and software implementations are supported by the platform. The remote design utilizes a low power 8-bit PIC18F452 microcontroller and XBee wireless transceiver module because it need low power consumption. The designed TRG remote platform should provide protocols for device discovery and establish multi-hop, real- time communication from a sensor node to the base station, as well as a simple query interface that supports medical application requirement [3].

Research by Kemis et.al has made a Healthcare Monitoring Application in Ubiquitous Sensor Network: Design and Implementation based on Pulse Sensor with Arduino [4]. Vital sign parameters that were monitored, limited of heart rate through the internet network.

Another study by Firdaus et.al, present a microclimate telemonitoring using wireless sensor network ZigBee[5]. The focus of his research is to make a microclimate telemonitoring using 5 ZigBee nodes, one node as coordinator and four nodes as sensor nodes [5].

In this paper, we present multipoint vital sign monitoring system using ZigBee wireless sensor network. Patient's vital signs are acquired by a multi parameter sensor device (MGW830). By MGW830, the signal is digitizing and then sent serially to the monitor computers using ZigBee as a medium of communication. The main contribution of this research is: create a vital sign monitoring system using ZigBee and the parameters of signal can be seen from two remote computers wirelessly.

The main contents of this paper are organized as follows; Section II presents a description of the design and implementation of the system. Section III provides the brief description of the test result then the Conclusions at section IV.

II. Design and Implementation

A. Vital Sign Monitoring Hardware

Vital Sign Monitoring hardware is used for ECG, temperature, and blood pressure signal acquisition process. The MGW830 processor board is used as vital sign monitoring hardware [6]. The MGW830 board include measurement circuits of physical parameters, such as ECG (Electrocardiogram), RESP (Respiration), NIBP (No Injury Blood Pressure), Temp (Temperature), IBP (Injured Blood Pressure), and so on. MGW830 board also communicates with the Personal Computer (PC) through a serial port. Serial port setting to operate this hardware as follows: Baud rate

115200bps, serial data format is 1 start bit, 8 data bits, 1 stop bits and no parity checking [6].

B. *ZigBee*

In this work, the data is transmitted wirelessly using XBee Series 2. XBee Series 2 is designed to operate within the ZigBee protocol and support for the needs of low cost and low power wireless sensor networks. Modules require minimum power and provide reliable long-distance data transmission between devices. XBee series 2 can be seen in Fig. 1[1].

Fig. 1. XBee Radios [1]

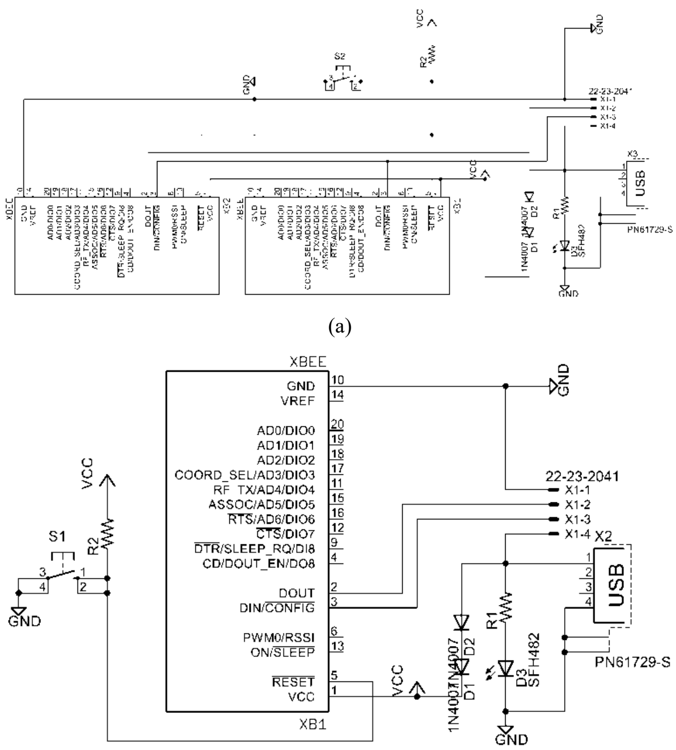
In this research, each PC is connected to the XBee then set as end device. On the sensor side (patient), XBee is functioned as coordinator to forward the data from the sensor device. To configure the XBee parameters is using the XCTU freeware application. The parameters setting of each XBee are shown in Table 1.

TABLE I. XBEE CONFIGURATION

Coordinator AT	
PAN ID	PAN ID *coordinator* 1 : PAN ID *end device* 1 PAN ID *coordinator* 2 : PAN ID *end device* 2
DH Address	DH *coordinator* 1 : SH *end device* 1 DH *coordinator* 2 : SH *end device* 2
DL Address	DL *coordinator* 1 : DH *end device* 1 DL *coordinator* 2 : DH *end device* 2
BD	115200
End Device AT	
PAN ID	PAN ID *end device* 1 : PAN ID *coordinator* 1 PAN ID *end device* 2 : PAN ID *coordinator* 2
DH Address	DH *end device* 1 : SH *coordinator* 1 DH *end device* 2 : SH *coordinator* 2
DL Address	DL *end device* 1 : SL *coordinator* 1 DL *end device* 2 : SL *coordinator* 2
BD	115200

C. *XBee Shield*

XBee shield serves as a serial interface between XBee and the sensor device or XBee with a PC. XBee shield designed consisting of an MAX232, Input/Output, power supply, and diodes to decrease the voltage. There are two XBee shields which are designed that are the XBee shield for coordinator and XBee shield for end device can be seen in Fig. 2.



(a)

(b)

Fig. 2. (a) Xbee shield for coordinator (b) Xbee shield for end device

D. *System Design*

The vital sign monitoring system design which is implemented in this paper can be seen in Fig. 4. The patient's vital signs were detected by the sensor will be the input and processed by the module MGW830, which is then forwarded to the XBee coordinator. XBee coordinator will send serially the data from MGW830 to XBee end devices. Finally, XBee end devices forward the data to personal computer for display on the monitor.

List of the devices that used in this research are:

Hardware Types	Device
Sensor and Actuator	ECG's Electrode Cuff Temperature Sensor
CPU unit	MGW830 Board - Processor - Communication Media - ADC
Transmission Module	XBee Series 2 (4 Unit) for Tx & Rx

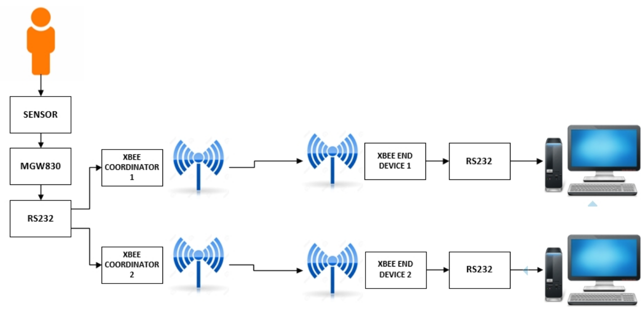


Fig. 3. System Design

When sending a command from software such as the measurement of blood pressure, pumping cuff command will be sent from the PC to the end devices 1 through MAX232 to convert RS232 voltage levels to TTL voltage levels. Then the command is sent by the end device 1 to the coordinator 1. The communication from end device 1 to the coordinator 1 is unicast so that the command will only be sent directly to the coordinator node 1.

After coordinator 1 takes from end devices 1, the command will be forwarded to MGW830 through MAX232 to convert the TTL voltage levels to the RS232 voltage levels. Then MGW830 will pump the cuff, and the measurement results will be sent to two nodes end devices.

Doctors can monitor vital signs graph of a patient from MGW830 application. The display of MGW830 application can be seen in Fig. 4.

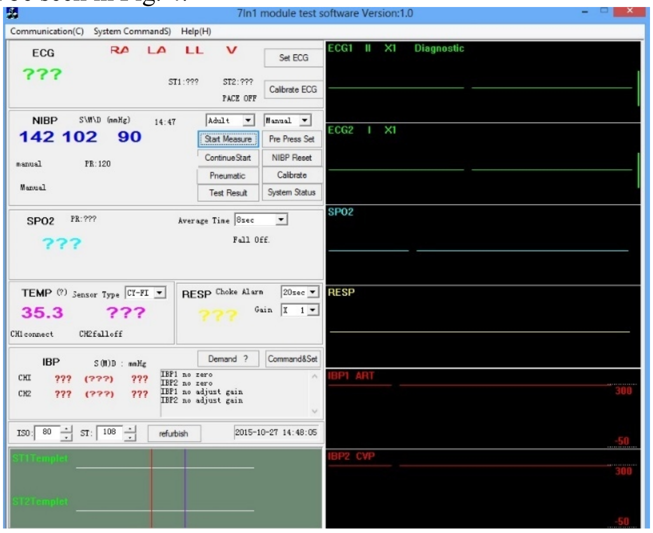


Fig. 4. MGW830 application

III. Result and Discussion

In this section, we discuss the system testing result. There are five testing scenarios: hardware, baud rate, data rate, XBee communication range, software. The analysis focuses on the application performance in representing data.

A. *Hardware Testing*

Hardware testing is performed to see if the device can work according to design requirements. Testing is done by installing XBee and XBee shield and given a 5 volts power supply. Then see LED and measured voltage into the first leg XBee and Vcc pin on the MAX232. The test result can be seen in Table 2.

TABLE II. Hardware Testing Result

XBee Shield	Power Suply	LED	Test result	
			Pin 1 XBee	Pin Vcc MAX232
XBee *shield coordinator*	5 Volt	Blink	3.3 Volt	4.8 Volt
XBee *shield end device* 1	5 Volt	Blink	3.3 Volt	4.8 Volt
XBee *shield end device* 2	5 Volt	Blink	3.3 Volt	4.8 Volt

Based on test results in Table 2, XBee shield is able to communicate well with a sensor device or PC.

B. *Baud Rate Testing*

Baud rate testing is performed to determine the proper baud rate. Testing is done by changing the baud rate value then seen its influence on the data received by the MGW application and HyperTerminal application. The test result can be seen in Table 3.

Based on test result in Table 3, the proper baud rate is 115200, it is because the default baud rate in MGW830 sensor device is 115200. Based on this test, software application of MGW30 will be able to work well with a minimum 115200 of baud rate.

TABLE III. Baud Rate Test result

No	Baud Rate	Data	
		MGW830	Hyperterminal
1	9600	Undetected	Detected
2	19200	Undetected	Detected
3	38400	Undetected	Detected
4	57600	Undetected	Detected
5	115200	Detected	Detected

C. *Data Rate Testing*

Data rate testing is performed to determine how much data transmitted by the sensor device to the PC via serial cable communication and XBee communication. Testing is done by connecting the sensor device MGW830 to the PC via a serial cable and via XBee. The data received will be monitored using Hyperterminal software. Then the data received for ± 5 seconds will be measured. This test is performed five times. The test result can be seen in Table 4 and Table 5.

TABLE IV. Data Rate Via Serial Cable CommunicationTest Result

No	Data Received (Byte)	Data *Rate* (Byte/second)
1	29677,0	5935,4
2	30610,0	6122,0
3	30863,0	6172,6
4	28840,0	5758,0
5	28621,0	5724,2
Average	29722,2	5944,4

TABLE V. Data Rate Via XBee Communication Test Result

No	Receiver 1		Receiver 2	
	Data Received (Byte)	Data *rate* (Byte/second)	Data Received (Byte)	Data *rate* (Byte/second)
1	17901	3580,2	18706	3741,2
2	18245	3649,0	19608	3921,6
3	17266	3453,2	19401	3880,2
4	18091	3618,2	16910	3382,0
5	17446	3489,2	18829	3765,8
Average	17789,8	3507,5	18690,8	3738,2

Based on test result in Table 4 and Table 5, the size of the data transmitted by the MGW 830 device to a PC is larger than the ability of XBee in sending and receiving data.

D. XBee Communication Range Testing

XBee communication range testing is performed to determine the ability of XBee communication range with conditions in the room either in an LOS (Line of Sight) and NLOS (NonLine of Sight). The test result can be seen in Table 6 and Table 7.

TABLE VI. XBEE COMMUNICATION RANGE IN LOS CONDITION

No	Range (meter)	Data Sent (Byte)	Data Received
1	5	700	700
2	10	700	700
3	15	700	700
4	20	700	700
5	25	700	700
6	30	700	700
7	35	700	700
8	40	700	700

TABLE VII. XBEE COMMUNICATION RANGE IN NLOS CONDITION

No	Range (meter)	Data Sent (Byte)	Data Received (Byte)
1	5	700	700
2	10	700	700
3	15	700	700
4	20	700	700
5	25	700	700
6	30	700	700
7	35	700	653
8	40	700	0

Based on test results in Table 7, in LOS conditionXBee can receive 700 bytes data sent with a maximum range 40 meters with no missing data. While in NLOS condition, XBee can receive 700 bytes data sent with a maximum range 35 meters, but there are missing data, this is caused by several factors, one of it is the existence of a wall or obstacle.

E. Software Testing

Testing the temperature sensor is performed to determine whether the temperature data from the sensors are sent to PC via the XBee communication are well received. Testing is done by measuring the temperature ± 2 minutes and compares the value of temperature measurements at each receiver. The receiver is connected to sensor device via serial cable communication, or through XBee communication. This test is performed ten times. The result can be seen in Table 8.

TABLE VIII. TEMPERATURE TESTING RESULT

NO	Temperature			
	Via Serial Cable	Via XBee		*Error* (%)
	Temperature (ºC)	Receiver 1 Temperature (ºC)	Receiver2 Temperature (ºC)	
1	35,3	35,3	35,3	0,00
2	35,5	35,6	35,6	0,28
3	35,6	35,6	35,6	0,00
4	35,7	35,8	35,8	0,28
5	35,8	35,8	35,8	0,00
6	36	36	36	0,00
7	35,7	35,7	35,7	0,00
8	35,2	35,2	35,2	0,00
9	35	35,1	35,1	0,29
10	35,1	35,1	35,1	0,00

Blood pressure sensor testing is performed to determine whether the PC receives the blood pressure data from the sensors via the XBee communication. Testing is done by measuring the blood pressure every ± 10 minutes and compares the value of blood pressure measurements at each receiver, connected via serial cable communication, or via through XBee communication. Tests performed ten times. The result can be seen in Table 9. The error happened because the data transfer rate on the XBee is smaller than the minimum requirement of MGW830. This is demonstrated in testing results on Table 4 and 5.

TABLE IX. BLOOD PRESSURE TESTING RE B SULT

NO	Blood Pressure			
	Via Serial Cable	Via XBee		*Error* (%)
	Blood Pressure S/M/D(mmHg)	Receiver 1 Blood Pressure S/M/D(mmHg)	Receiver 2 Blood Pressure S/M/D(mmHg)	
1	139/88/75	0/0/0	0/0/0	100,00
2	156/105/91	158/108/92	0/0/0	49,40
3	158/94/76	158/98/84	158/98/84	5,26
4	157/101/79	0/0/0	0/0/0	100,00
5	153/93/75	151/102/75	0/0/0	50,33
6	154/98/82	158/115/80	0/0/0	49,96
7	149/94/70	145/86/64	145/86/64	5,63
8	153/101/82	0/0/0	0/0/0	100,00
9	142/87/53	0/0/0	143/79/55	48,88
10	146/97/84	0/0/0	0/0/0	100,00

ECG testing is performed to determine whether the ECG data from the sensors are received correctly by the PC via the XBee communication. Testing is done by measuring the blood pressure every ± 10 minutes and compares the value of blood pressure measurements at each receiver, connected via serial cable communication or XBee communication. Tests performed ten times. The result can be seen in Table 10.

TABLE X. ECG TESTING RESULT

No	ECG data			
	Via Serial Cable	Via XBee		*Error*
	ECG	ECG	ECG	(%)
1	100	101	101	1,00
2	99	100	100	1,01
3	102	102	102	0,00
4	97	99	99	2,06
5	101	100	100	0,99
6	102	102	102	0,00
7	101	100	100	0,99
8	97	97	97	0,00
9	102	104	104	1,96
10	108	106	106	1,85

Based on the result in Table 8, Table 9, and Table 10, The average error for temperature measurement is 0.085%, the average error for heart pressure measurement is 60.946%, and the average error for pulse rate measurement is 0.986%.

IV. CONCLUSION

The results indicate the multipoint vital sign monitoring system using ZigBee wireless sensor network has worked well. The system can simplify vital sign monitoring of patient's body process from a distance using a PC wirelessly. The average error of temperature measurement is 0,085%, the average error of blood pressure measurement is 60,946%, and the average error of pulse rate is 0,986%. Errors are caused by extensive data transmitted by the sensor exceeds the capabilities of ZigBee communication. To solve the effect of data transmission errors, can be performed by replacing the UART system with high-speed communication protocol for example USB standard.

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