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TABLE OF CONTENTS

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EDITORIAL

It is my proud privilege to welcome you all to the Researchfora International Conference at Hamburg, Germany in association with The IIER. I am happy to see the papers from all part of the world and some of the best paper published in this proceedings. This proceeding brings out the various Research papers from diverse areas of Science, Engineering, Technology and Management. This platform is intended to provide a platform for researchers, educators and professionals to present their discoveries and innovative practice and to explore future trends and applications in the field Science and Engineering. However, this conference will also provide a forum for dissemination of knowledge on both theoretical and applied research on the above said area with an ultimate aim to bridge the gap between these coherent disciplines of knowledge. Thus the forum accelerates the trend of development of technology for next generation. Our goal is to make the Conference proceedings useful and interesting to audiences involved in research in these areas, as well as to those involved in design, implementation and operation, to achieve the goal.

I once again give thanks to the Institute of Research and Journals, Researchfora, TheIIER for organizing this event in Hamburg, Germany. I am sure the contributions by the authors shall add value to the research community. I also thank all the International Advisory members and Reviewers for making this event a Successful one.

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■■■

A CONTROL SYSTEM DEVELOPMENT BY WIRELESS BODY AREA NETWORK FOR HOUSEHOLD ELECTRICAL EQUIPMENT

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Abstract - A developed electric control system using Wireless Body Area Network (WBAN) uses a medical communication technology to apply for controlling an electric system in a smart home system. There is separated in two parts of the system. The first part is a center control that consists of a microcontroller and a wireless system receiver. The second part is a vital sign detector and a wireless signal transmitter to a center control part. This system measures a vital sign of a user. Also, this system will command to control an electric system work when a user is in an area of a center control function. A transmitter using a vital sign detector will have an encryption in order to specify for a priority to control. As well, using a WBAN system to control an electric system in a smart home system can reduce an energy using efficiently.

Index Terms - Smart Home, Wireless Body Area Network, ZigBee

I. INTRODUCTION

Nowadays, there is a global warming condition in the earth. Furthermore, a temperature will be increased continuously. An electricity production is another cause of a global warming condition. A part of this electricity is used in a household. In consequence, an electricity saving is another method to solve this problem. Electricity using for lighting in the households and buildings is 25 percent of the whole electricity using. Moreover, an efficient use of electricity for lighting can save an electric energy from 1 to 5 percent.

A smart home system uses a technology to control any equipment in a household. To facilitate for the household members, it has an energy management system including inside and outside security system. It is controlled by a computer system at most. Equipment using in a smart home is separated in 3 parts as a smart home network, a smart home controller, and a home automation.

Then, the researcher presents an idea to develop the system by using WBAN with a smart home. In a home automation, it uses WBAN to send a vital signal to control an electric system. The system will investigate that human comes to a specified area. Also, it commands to control for turning on and turning off and electrical equipment in a household. The reason is to be a prototype for a WBAN system development using in a work of smart home.

II. LITERATURE REVIEW

A. Microcontroller

A microcontroller is a kind of a computing electronic chip. It processes by a program or a set of command. An inside structure of a microcontroller is a big compound circuit. It consists of a mathematical computing unit, a logic bus, a port, a register, a memory unit, a counting circuit, and a timer circuit together in a microcontroller. It is designed for using in a control work and can connect with the input and output equipment. As well, it can work using only one equipment or can access in a bit of data. A program controlling a microcontroller uses a high level of many programming languages. As a result, it is convenient to learn how to design a system development circuit. A difference between microprocessor and microcontroller is can access to a bit of data and many high level programming languages. So, it is easy to learn.

B. Body Area Network

A Body Area Network (BAN) is a system that a user can send a data as a communication via a human body. It is necessary to touch a human body for that communication. In addition, it works with sensor detecting on a human body or embedded in a human body. For example, breathing, heartbeat, glucose quantity, blood pressure, muscle movement, etc. These detecting sensors are in a Body Area Network (BAN). A human body touching system uses our body as a signal line to receive and send a data as shown in Figure 1.

After using a BAN technology in a medical service management, it facilitates for everybody in the medical system. A patient gets more comfortable that is not necessary to wear wired equipment. Furthermore, it reduces for an admission payment of a patient during staying in a hospital. A doctor reduces time to take care of a patient. In consequence, a doctor can do for a

healing with a patient more convenient.

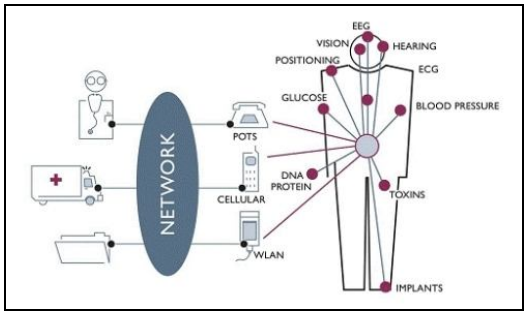

Figure 1: Body Area Network System

C. Wireless Body Area Network

A Wireless Body Area Network (WBAN) [3] is a wireless data transmission method that implements in a term of the telemedicine system in step by step. The system process can be described in Figure 2.

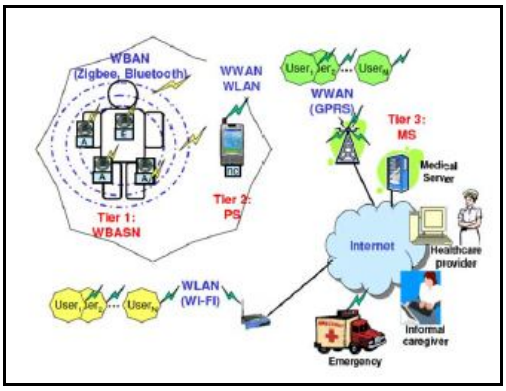

Figure 2: Health Monitoring System Network Architecture

WBAN is a new innovation implementing in a health care system that investigates and determines a signal from a human body. It acts like a communication network for any organ in a human body. Before that, a human communication will concern with only 3 organs as eyes, ears, and mouth such as watching the movie, listening to the music, playing the internet, talking via the telephone, etc. But nowadays, a BAN technology specifies on a communication by all the organs in a human body. Then, a BAN technology is directly useful in a medical health care management. For instance, an efficiency measurement of a human body, a symptom tracking for a patient, a caring system of the elderly people and disabled, a correctly and on time diagnose, etc. There are some examples of signal detection equipment or a sensor in each position of a human body such as Electroencephalography (EEG) for a brainwashed measurement, Electrocardiogram (ECG or EKG) for a heart wave measurement, a blood pressure measurement, a hearing measurement, a visibility measurement, a movement measurement, a muscle elasticity measurement, etc. This equipment can send a data signal to a smart phone that processes as all signal receiver center for an initially processing as explained in Figure 3.

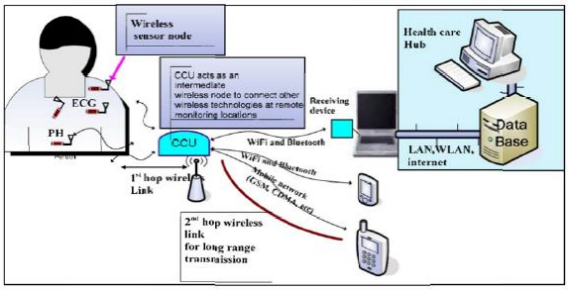

Figure 3: WBAN System for Control and Investigation

D. ZigBee

ZigBee is a wireless communication technology that is developed to be featured than other wireless technologies. The advantages are low cost, use less energy, long time implementation, and network creation. It is suitable to implement with a wireless sensor for object and surrounding investigation. Furthermore, it can compare between ZigBee and other wireless technologies in Table 1.

Standard	ZigBee 802.15.4	Wifi 802.11b	Bluetooth 802.15.1
Transmission Range (meters)	1-100	1-100	1-10
Battery Life (days)	100-1,000	0.5-5.0	1-7
Network Size (# of nodes)	>64,000	32	7
Stack Size (kb)	4-32	1,000	250
Throughput (kb/s)	20 - 250	11,000	720
Application	Monitoring & Control	Web, E-mail, Video	Cable Replacement

Table 1: Comparison between ZigBee and Other Wireless Technologies

From Table 1, a Zigbee network system has a longer lifetime that other network systems a lot. Also, it is better to support for an extension. As well, it has a less quantity of a data transmission because of a small node for that data transmission. And then, it is effective to apply in a WBAN system modeling.

III. RELATED WORKS

B. Eamthanakul, M. Ketcham, and S. Sansiribhan do a research named An Electric Energy Management System for Smart Classroom by Using Multi Sensors. The main objective of this research is to study and develop an electric energy management for a smart

classroom by using the multi sensors. When the multi sensors work as specify, the system commands the multi sensors to begin or finish for working [4].

D. M. Han and J. H. Lim do a research named Design and Implementation of Smart Home Energy Management Systems based on ZigBee. This research explains about a system design of a smart home energy management. It uses a ZigBee technology as a medium to communicate inside a household [5].

D. Yan and Z. Dan do a research named ZigBee-based Smart Home System Design. This research describes about a smart home system design. A ZigBee network is used to communicate between a home gateway and other equipment. Moreover, it has a suggestion of an idea to connect with other wireless systems such as in a mobile phone [6].

E. Jovanov, A. Milenković, C. Otto, P. DeGroen, B. Johnson, and S. Warren do a research named A WBAN System for Ambulatory Monitoring of Physical Activity and Health Status Applications and Challenges. This research explains about a preparation of an investigation system for a patient health activity and exercise. The system uses an ECG measurement to send a data by a ZigBee technology as well as using a computer for a data recording and a computation [7].

M. Sripan, X. Lin, P. Petchlorlean, and M. Ketcham do a research named Research Thinking of Smart Home Technology. This research describes about what a smart home system is, how it works, what kind of technology using for commination. In addition, it refers to how it is useful for saving energy, a facility, and a security [8].

N. Sombuntawee does a research named Wireless Control System in Industrial Process in Case of Liquid Level Control. This research explains about an apply for using a ZigBee network for an industrial process control and a data transmission ability investigation [9].

S. Sansiribhan, P. Meeto, P. Watcharatangka, E. Ruenyos, O. Rewthong, and U. Boonhumroong do a research named Wireless Controlling System Using Arduino and ZigBee for Home Automation. The aim of this study is to design the wireless control system for home automation. The home automation system is based on the Arduino microcontrollers, the relay control module, ZigBee and Ethernet [10].

S. Siripreedakul and P. Jirakulkanok do a research named Power Control System Development by Zigbee. This research describes about a smart electric control system. The system controls brightness from a long distance. Furthermore, the system can investigate that an electric equipment has an electricity flows inside or not. If there is electricity flows inside, the system will command to stop that flowing of electricity [11].

A. Dinh and T. Wang do a research named Bandage-Size Non-ECG Heart Rate Monitor Using ZigBee Wireless Link. The research implements a Non-ECG system for vital signs measurement. Moreover, it is a ZigBee implementation to send a data from a detector. In addition, it sends a wireless data using ZigBee network that using less energy to a data receiver connecting to a computer [12].

M. K. Hansen and S. Stoa do a research named Practical Evaluation of IEEE 802.15.4/ZigBee Medical Sensor Networks. A WBAN network sends a data from an investigator by a ZigBee network to a computer. By the way, this research will measure for a serviced area of the system [13].

E. Leelarasmee and S. Dechjarasyothin do a research named A Smart Lighting Control System Using DALI Protocol. The research creates a smart system to control brightness of a fluorescent light bulb by a DALI protocol. This controller can control a brightness system automatically or directly from a computer via a wireless system using a ZigBee module [14].

IV. METHOD

A. System Design

To design for a WBAN electric control system, it could be separated in 2 parts. The first part is a hardware design for a vital sign transmitter system. The second part is a signal receiver for an electric circuit control.

1. Hardware Design for Vital Sign Transmitter System: There are 6 parts in this design as sensors for vital sign measurement, Amplifiers/Multiplexer, Controller, Radio Transceiver, Power Management, and Battery. The system will receive a vital sign by detecting from a sensor. Next, the system sends a data value to Amplifiers/Multiplexer. After that, Amplifiers/Multiplexer extends an investigated signal. And then, the signal sends to a controller part for all control in the system including a signal transmitter part as shown in Figure 4.

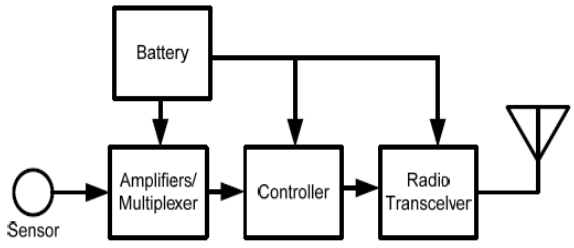

Figure 4: Process of Vital Sign Transmission

2. Signal Receiver for Electric Circuit Control: A Central Control Unit (CCU) is a sensor to measure for a vital sign. It has 4 parts as Controller, Radio Receiver, Load Control, and Battery as shown in Figure 5.

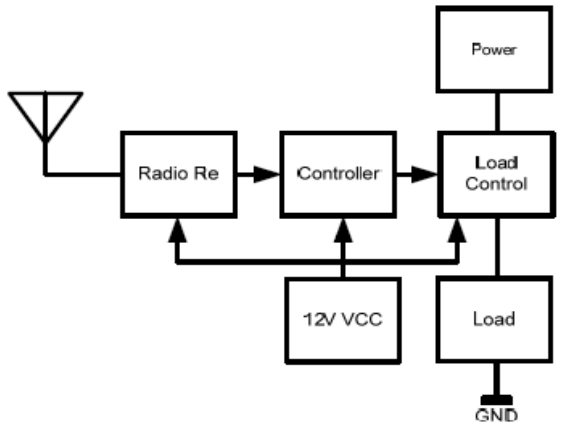

Figure 5: Process of Central Control Unit

A central control unit receives a data from a ZigBee network and transfers to a microcontroller. After that, a microcontroller commands a load control. Also, ZigBee wireless signal equipment will send and receive data by itself.

B. System Development

1. Vital Sign Transmitter System Equipment Development
2. Central Control Unit Signal Receiver Equipment Development
3. Software System Development: After that, it compiles to a computer language from programming in a microcontroller.
4. Testing and Result Analysis from Sensor and Microcontroller: After that, it concludes for an experiment result in order to adjust and develop later.

Furthermore, all the parts will assemble to architecture of a WBAN System for Smart Home Energy Management as shown in Figure 6. A vital sign measurement sensor will be attached to a user. When a sensor receives a vital sign, it will send a data value to a microcontroller and send an output by a Zigbee network. When a user comes in an area that a CCU works, a CCU can connect with a user. Then, a CCU will command to electrical equipment for switching on or off. Inside a CCU, it consists of a Zigbee signal receiver that receives a signal from a signal transmitter and sends a data value to a MCU for a load control of electrical equipment.

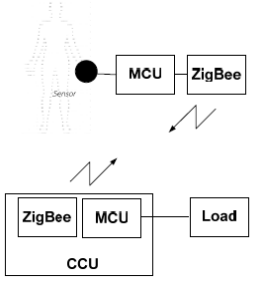

Figure 6: System Architecture

C. System Testing

It is separated in 2 parts for a control system testing.

1. Control Ability Testing: There are 30 tests in order to test for all the control system and test how distance from a control area. Then, it tests for a distance that the system can control for a CCU as shown in Figure 7.

Figure 7: Control and Distance Ability Testing Prototype

2. Before and After Energy Use Result Testing: In order to determine that the system can reduce an energy use or not within 30 days. An electric control system uses a WBAN network to record the results and continues to record until complete in 30 days. After that, the system results are compared for a reduction to use energy as shown in Figure 8.

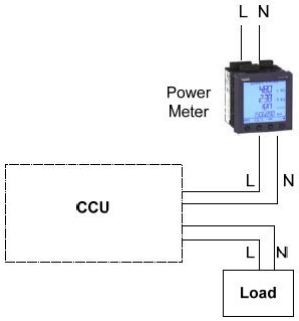

Figure 8: Circuit Connection for Energy Measurement Testing

V. RESULT

The system results are categorized in 2 parts. The first part is control accuracy and a control area distance. The second part is an energy use result before and after system implementation.

1. Control Accuracy and Control Area Distance: It can be shown in Table 2.

Distance (meter)	Testing Amount (time)	Light Bulb Turning On Ability Amount (time)	Percentage
1	30	30	100
2	30	30	100
3	30	30	100
4	30	30	100
5	30	29	96.66
6	30	29	96.66
7	30	0	0
8	30	0	0
9	30	0	0
10	30	0	0

Table 2: Control Accuracy and Control Area Distance

From Table 2, accuracy efficiency for an electrical control circuit control is 100% from 0 to 4 meters in distance. After that, an accuracy value is 99.66% from 5 to 6 meters in distance. But from 7 meters in distance or more, the system cannot control to turn on the light bulb at all.

2. Energy Use Result before and after System Implementation: In order to test that the system can save an energy or not. The system is connected with a light bulb as a load in an office area with 36 Watt lamp. A lamp uses electricity at 13.42 units before using a WBAN electric control system. But after using a WBAN electric control system, a lamp uses electricity at 7.71 units. So, the system can save an electric energy at 5.71 units as shown in Figure 9.

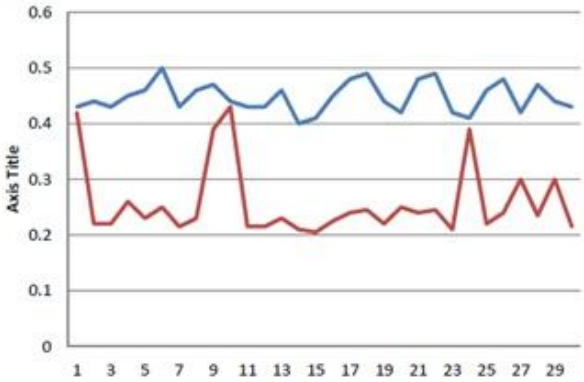

Figure 9: Electricity Use Comparison Graph between before and after Using WBAN Electric Control System

CONCLUSION

This research presents the design and implementation methods of WBAN electric control system. The system uses electronic and microcontroller technologies for a system development. In addition, the system uses an applied medical communication technology to control an electric system of a smart home system. So, it can manage to use and energy effectively as well as reduce to use energy efficiently. From this research, the system can be used as a prototype for using a WBAN technology to control an electric system in a smart house system.

Here are the results from a WBAN electric control system. First, the system can control an electric system within 4 meters in a distance at 100%. Second, the system can control an electric system within 5 to 6 metres in a distance at 99.66%. As well, here are the results for electricity saving using a 36 watt light bulb as a load for 30 days. First, an electrical lamp uses electricity at 13.42 units. But after connecting with a WBAN electric control system for another 30 days, an electrical lamp uses electricity at 7.71 units. It refers that using a WBAN network can reduce to use an electric energy efficiently.

After the system results also a method of a WBAN technology, it can be studied and developed into a system in our daily lives especially for more saving in an electric energy.

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