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Multipoint Communication for Vital Sign Monitoring System

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Abstract: Vitals sign monitor is typical medical instrument for basic physiological measurement. Doctor determines patient's health condition by observing measurement result shown in display. In this research, we design multipoint vital sign monitoring system. Patient's vitals sign monitored are ECG, PPG and body temperature. These signals are transmitted using wireless LAN to multipoint users. To evaluate the performance of the system, we measure delay, throughput, packet loss and the number of end users who can connect to the server. From the testing we conclude that the system works well with all network parameters are in acceptable value.

Key words: Vital sign monitor · Wireless LAN · Multipoint communication · Electrocardiogram · Body temperature · Photopletysmograph

INTRODUCTION

Vital sign monitor or multi-parameter patient monitor is medical device that used to measure patient bio-signals. Signals measured by vitals sign monitor are electrocardiogram (ECG), non-invasive blood pressure (NIBP), respiration rate (RR), body temperature and blood oxygen saturation [1]. Number of signal measured by the vital signs monitor is depending on the needs. These devices are often encountered in the operating room or the intensive care unit (ICU). Doctor or nurse observes patient condition trough signal display in vital sign monitor. This device can be in the form a portable device with a display screen or it could be a wearable device with wireless communication [2-3].

In our previous research, we designed wireless vital sign using wireless LAN. Vitals sign form patient are transmitted via wireless LAN so that the patient data can be observe using PC or tablet PC Error! Reference source not found. In our previous work, one device only connected to one PC or tablet PC so it will spend resources.

Some research has been developed multi node ECG monitoring system for home tele-care system Error! Reference source not found.. The system uses only one client although ECG signal transmitted in multi node. In other research, we had tried to transmit multi signal using zigbee 5. ZigBee has advantages for security and power consumption, but less flexible because it requires additional module in the client for data receiver.

Seeing these problems, in this study, a system for monitoring of vital signals in multipoint was designed. With a system that is designed, the vital sign monitor can be accessed from multiple devices simultaneously so that resources can be saved.

Wireless Lan Vital Sign Monitor

Hardware Subsystem: First, we will describe about wireless vital sign monitor as shown in Figure 1. The devices captured ECG, photoplethysmogram (PPG) and body temperature signal. All these signals are multiplexed in microcontroller and then transmitted using wireless LAN module. Then the data is received and displayed in doctor's PC. The following sections will explain the data acquisition.

ECG signal is a signal generated by the heart as the representation of the electrical activity of the heart. By looking at the ECG signal will be known to a person's level of cardiovascular health. ECG signal assessed from the shape, orientation and rhythm 0. We use Einthoven's triangle for electrode placement. The ECG device is made as shown in Figure 2.

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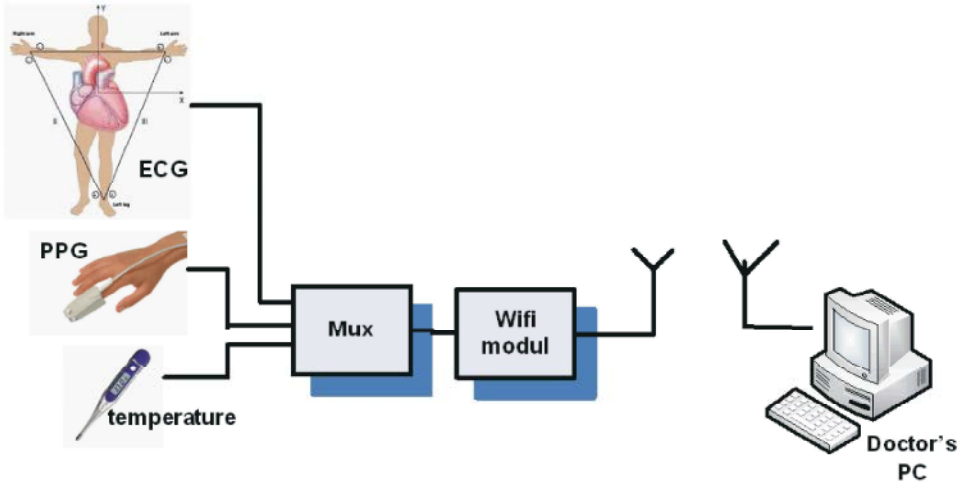

Fig. 1: Our previous work Error! Reference source not found

Fig. 2: Block Diagram of ECG device

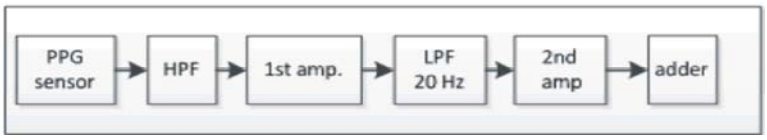

Fig. 3: Block Diagram of PPG Device

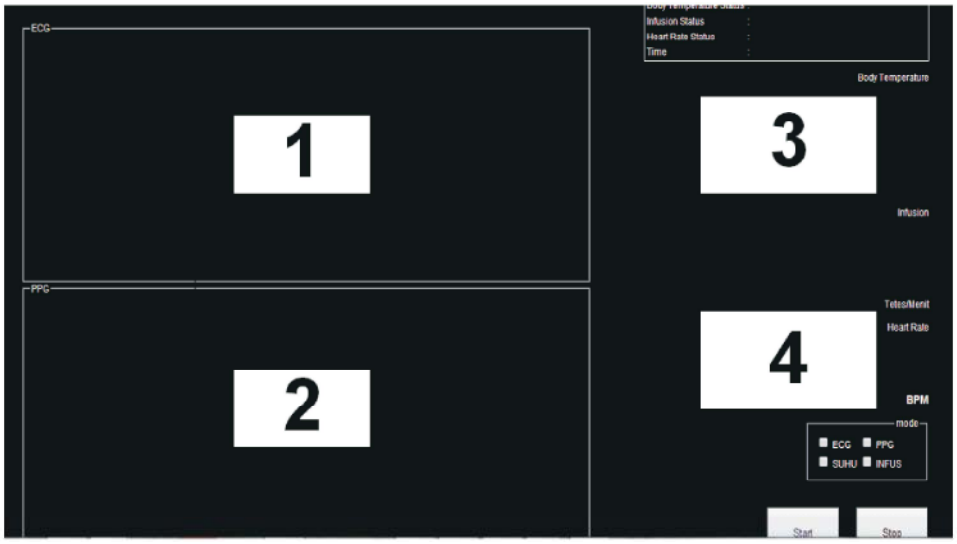

Fig. 4: Graphical user interface

Photoplethysmograph (PPG) is a technique for measuring changes in the volume of a body part/organ by utilizing optical phenomena [8]. PPG used in this study to measure changes in blood volume in the finger to monitor the pumping of blood by the heart. Information taken from the PPG signal can be used to count the number of heartbeats. The PPG device is made as shown in Figure 3.

In vital sign monitor device, LM 35 is used as temperature sensor. ATMEGA16 microcontroller acts as data digitalizing and multiplexing. For transmitting data wirelessly, we use Wiz610wi module from Wiznet.

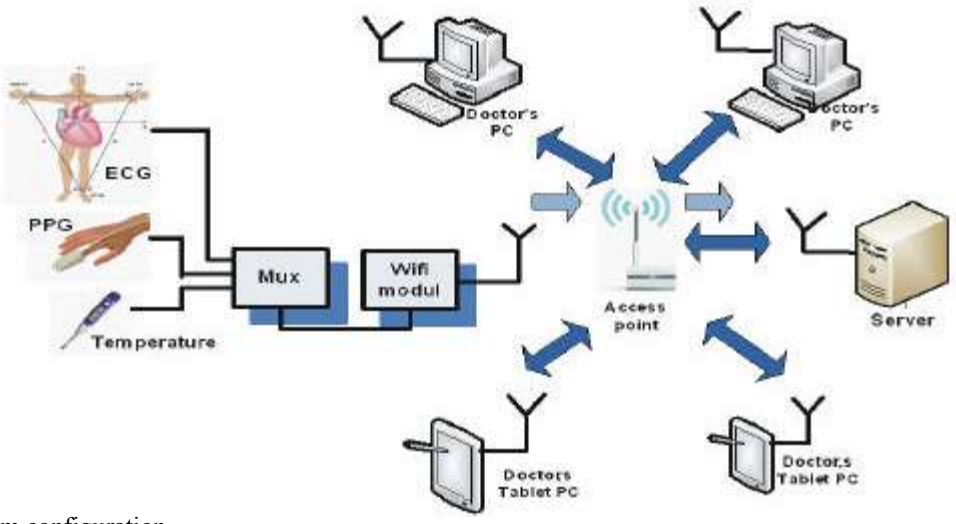

Fig. 5: System configuration

Software Subsystem: The software receives data, perform signal de-multiplexing and display signal measurement results. Figure 4 shows the GUI for this application. ECG data is displayed as graphical format in (1), PPG is displayed in (2), while body temperature and heart beat are displayed as numeric form in (3) and (4) respectively.

Multipoint Wireless Lan Vital Sign Monitor System: To improve the performance of the system have been made, that communication was originally only for point-to-point made into a point-to-multipoint, we made web server with configuration as in Figure 3.

Data from the device is sent to the server through the access point. Server receives and record data. Other devices can access the data through the server. The arrow indicates the direction of data transmission from the server to the device while the 2-way arrow image shows the connection between the server and the client [9].

There are 2 scenarios relationship between the device to the server, real-time and non real-time mode. In real-time mode, data is sent to the server and accessed directly by the client. The software used is node.js and data parsing using PHP. Client accesses server using web browser.

In non real-time scenario, the data previously recorded on the server using real-term software. Client accesses recorded data on the server using web browser [10].

RESULT AND DISCUSSION

System that already designed was examined its performance for analysis purposes. Some parameters are used in this measurement, such as delay, throughput, packet loss and the number of end users who can connect to the server.

Delay: Figure 6 shows relation between delay and number of users. According to [9], one-way delay should be less than 150 ms, but the best delay for data service is about 30 ms. We can infer from figure 6 that the growing number of users will increase the delay. For 20 users, the end to end delay reaches 10 ms. The lower the delay, the better the system performance.

Packetloss: Figure 7 show that the packet loss in real-time and non-real time tested is 0%. This is because the data transmission using TCP, which is reliable for any lost datas will be resent.

Server Time and Cpu Usage: Performance of the system is measured based on server access time of 20 simultaneous users at one time, as well as the resource usage of the CPU when all connections made from 20 users simultaneously. The results obtained are both access time and CPU usage is proportional to the number of user connections. Figure 8 and Figure 9 show the details of the results.

Figure 10 shows application in client side. ECG and PPG signal are displayed simultaneously in graphic format. Body temperature and heart beat are displayed in numerical form. All signal captured form the device are received correctly in client side.

The test result shows that the multipoint monitoring vital signs system on the device has been successfully implemented. Network parameters tested were within

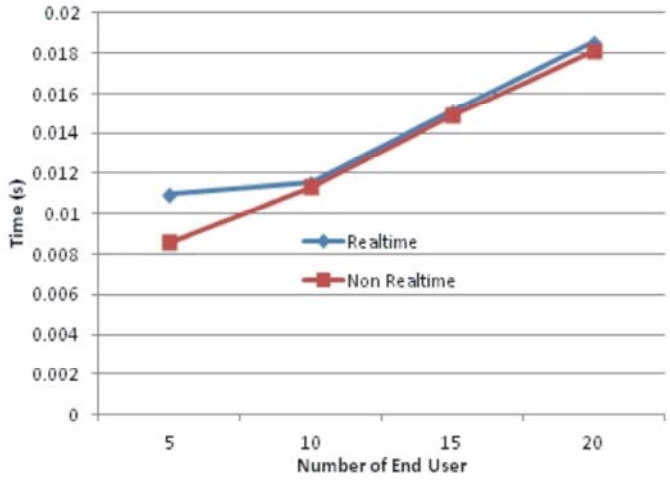

Fig. 6: End to end delay of end users

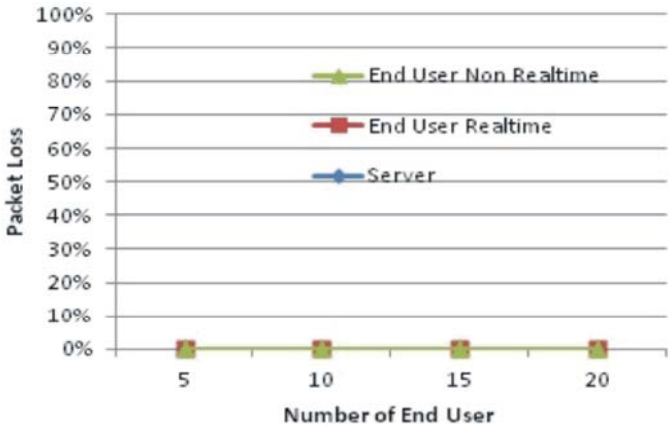

Fig. 7: Packet loss

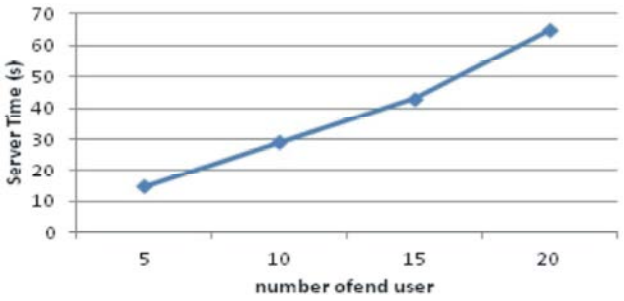

Fig. 8: Server time

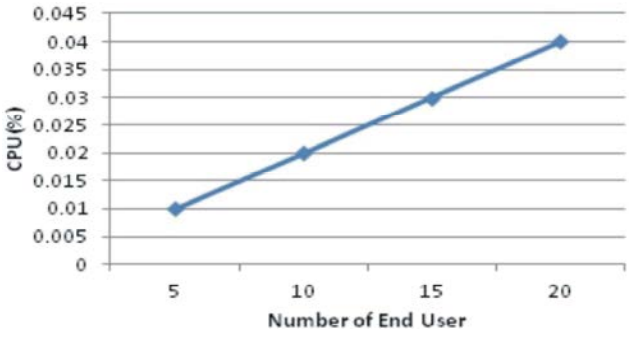

Fig. 9: CPU usage

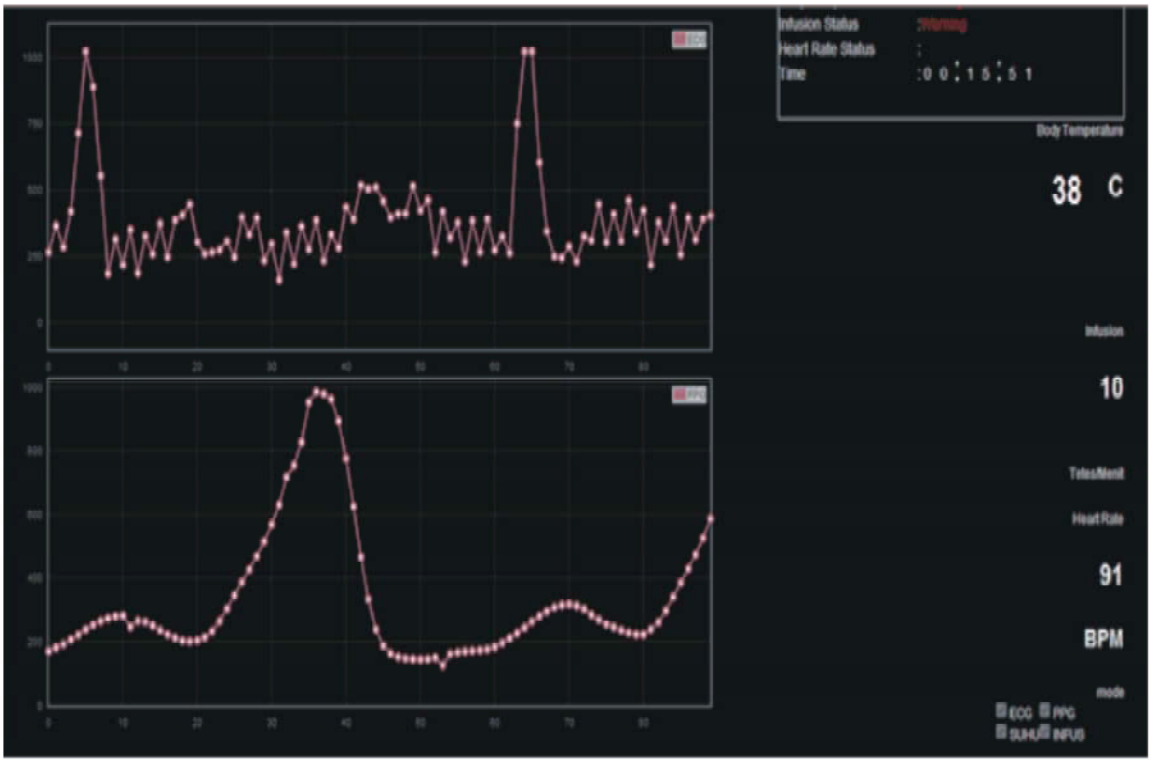

Fig. 10: Signal display on application

allowed value. In testing the number of users, users are limited to 20 considering the real conditions may be only 2 -3 user accessing the data from the device simultaneously.

CONCLUSION

Based on the implementation and testing the system, two conclusions can be drawn from this study. First, the vital sign monitor can be accessed by up to 20 devices with acceptable parameter such as delay and packet loss. Second, the data from server can be accessed in real-time mode or non real-time mode.

In future development, multi point vital signal monitor will be accessed by multi device. So, many patient data can be seen by many doctors or nurses. In this case, interferences between transmitters will be considered.

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