

Preliminary Study of Cloud Aided Monitoring of Basic Physiological Signals

Mei Liu^{*}, Ankang Lin^{*}, Rushan Wu^{*}, Sen Liu^{*}, Gaowei Lei^{*},
Junzhi Lu^{*}, Man Xie^{*}, Pao-An Lin^{**}, Junbai Wu^{*}, Bing-Yuh Lu^{*}

^{*}Faculty of Automation, Guangdong University of Petrochemical Technology, Maoming City, Guangdong, China

^{**}Faculty of Physics, Guangdong University of Petrochemical Technology, Maoming City, Guangdong, China

franklinlu888@outlook.com

Abstract— This study presents an instrument for basic physiological signal acquisitions which can be sent to cloud for monitoring and computation. The basic physiologic signals included user's temperature, breath and heart rates. The Bluetooth communication technology was employed to connect between the microcontroller module and notebook computer or smart phone. Because the raw data has been converted to values of heart and breath rates, the communication volume between client and cloud can be much reduced, as well as this technology can be employed for the other physiological signals to elevate the performance of this system in the near future.

Keywords— temperature, breath rate, heart rate, cloud, computation, Bluetooth communication.

I. INTRODUCTION

In 1983, the concept of "The network is the computer" was announced by Sun Microsystems. In March 2006, Amazon proposed the flexible computing cloud service. Furthermore, Eric Schmidt, the CEO of Google, first proposed the concept of "cloud computing" at the Search Engine Conference (SES San Jose 2006). Thereafter, "cloud computing" is a new application of the technology of networking.

In the previous studies, the physiological signals have been distantly measured for the health care of elders, miners, patients and so on [1-9]. However, the record and data process of the physiological signals in cloud is a new technology in recent years [10-15]. Consequently, we developed a system of cloud aided monitoring of basic physiological signals as a beginning of the study of cloud aided health care with much reduced communication volume.

He *et al.* [10] have proposed a 6-layer structure of a private cloud to serve the home health care. The communication media includes internet and cable TV networking. Pham *et al.* [16] studied on the home health care cloud. The communication media is internet network to connect cloud, user ends, and hospitals. In the user end, the physiological signals are transmitted by sensors with wired or wireless technology, and collected by personal computers (PC)

or smartphones. Moreover, Fabiano *et al.* [17] collect a big volume of physiological data in cloud to aid the recognition of patients' emotion. Therefore, the acquisition of physiological signals with cloud computation is a modern model of the distant home health care.

In addition, the strategies of the signal processing decide the accuracy and efficiency of the data acquisition. Artificial neural network (ANN) is a modern artificial intelligence (AI) method to process the signals. Many previous papers indicate the de-noising of respiration signals. Shi *et al.* have published a paper which indicated that lung sounds were de-noised by Wavelet method, and recognized by backpropagation neural network (BP). The recognition accuracy can be much improved [18]. Sankar *et al.* have proposed a method of feed forward-backpropagation networks to classify the respiration states [19]. In our study, the BP algorithm has been implemented in the microcontroller to count the breath and heart rates. An instrument for basic physiological signal acquisitions can send the read-outs to microcontroller and converted to the digital values of user's temperature, breath and heart rates for monitoring and computation. The physiologic signals are the crucial signals for monitoring.

II. METHODS

A. System structure

The system block diagram is presented in Fig. 1 which displayed four parts included sensors, microcontrollers, client, and cloud. The sensors contained the sensing of temperature, respiration, and heart beats. The microcontroller, ESP 32, connected with sensors, and processed the signals from the sensors. The BP technique was employed for de-noising of the signals of respirations and heart beats. Consequently, the processed data was transmitted by Bluetooth communication module to the client which might be a PC or smartphone. Finally, the data sent to the Tencent cloud for data storage, monitoring, and management.

B. Sensors

The sensor for detecting temperature is thermistor which is a small volume epoxy resin produced by new materials and

new processes. NTC thermistor has the advantages of high accuracy, small size, fast response, high stability, good interchangeability, and good consistency.

AD8232 is an integrated signal conditioning module for ECG and other bioelectric measurement applications. The device is designed to extract, amplify and filter weak bioelectric signals with noises which were caused by movement or remote electrode placement.

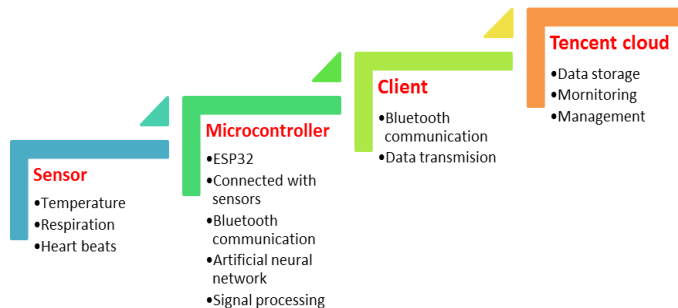


Figure 1. The system structure

C. Microcontroller

The microcontroller is ESP32 whose development board, NodeMCU-32S with the devices of Wi-Fi and Bluetooth communications was employed. The features of the board are as follows,

- Solutions for Wi-Fi & Bluetooth technology

ESP32 can be used as an independent system to run applications or as a slave device of the host MCU, providing Wi-Fi and Bluetooth communication technology through UART interfaces.

- High integration

ESP32 integrates functions such as antenna switch, RF balun, power amplifier, receiving low-noise amplifier, filter, and power management module. ESP32 requires very few peripheral components to achieve powerful processing performance, reliable security performance, and Wi-Fi and Bluetooth communications.

- Ultra-low power consumption

ESP32 is specially designed for mobile devices, wearable electronics and IoT applications. It has the industry's high-level low-power performance, including fine-resolution clock gating, power saving mode, and dynamic voltage adjustment.

- Stable performance

The performance of ESP32 is stable, and the operating temperature range is -40°C to $+125^{\circ}\text{C}$. The integrated self-calibration circuit realizes dynamic voltage adjustment, which can eliminate the defects of external circuits and adapt to changes in external conditions.

D. Client

The client means the user end of the communication between cloud and user. The client can be PC or smartphone which received the data by Bluetooth communication technology, and sent data to cloud on the internet or mobile communication stream.

E. Cloud

Tencent Cloud Server which works as a Cloud Virtual Machine (CVM) provides safe and reliable flexible computing services. Users can real-time expand or reduce computing resources, adapt to changing business needs, and only need to charge based on the resources actually used. CVM can much reduce the software and hardware resources and simplify IT operations and maintenances for users [20].

F. De-noise method

The microcontroller computes the breath and heat rates. Because of the environmental noises, the microcontroller has to cancel the noises of the signals. The algorithm of de-noising is BP which the abbreviation for error backpropagation neural network which is usually uses in combination with optimization methods (such as gradient descent), that calculates the gradient of the loss function for all weights in the network. This gradient will be fed back to the optimization method to update the weights to minimize the loss function.

BP requires a known output for each input value to calculate the gradient of the loss function. Therefore, it is generally regarded as a supervised learning method, which can iteratively calculate the gradient for each layer. In addition, BP requires the activation function of the neuron to be differentiable.

III. RESULTS

A. Data transmission

Figure 2 displayed the transmitted data in the client. The data format is user number, week day, day (month/day), time (hour : minute : second), signal types (heart rate / temperature / breath rate), and value of the data. The sequence of the data was acquisitioned from the sensors, and processed by the microprocessor, then sent the data sequence to client by Bluetooth communication technology.

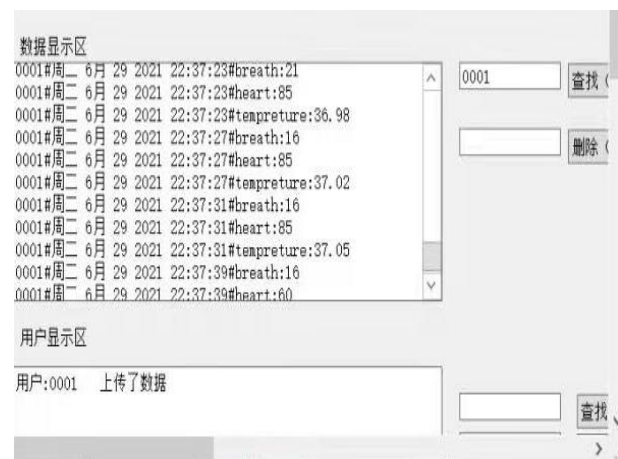


Figure 2. The transmitted dat in client

B. Data analysis

The users such as medical doctors in hospitals, patients and so forth can read the analysis of the data from Tencent cloud. The demonstration of the results is presented in Fig. 3. The red line is denoted for breath rate, blue line is heart rate,

and green line is the user's temperature. Furthermore, the digital form of the corresponding data also displayed in the top of the screen. However, if the basic physiological signals show the higher or lower values which indicate the abnormal sign, it will activate the alarm function to remind the medical staffs or patients to void the accidents. The remind information was displayed in Fig. 4.

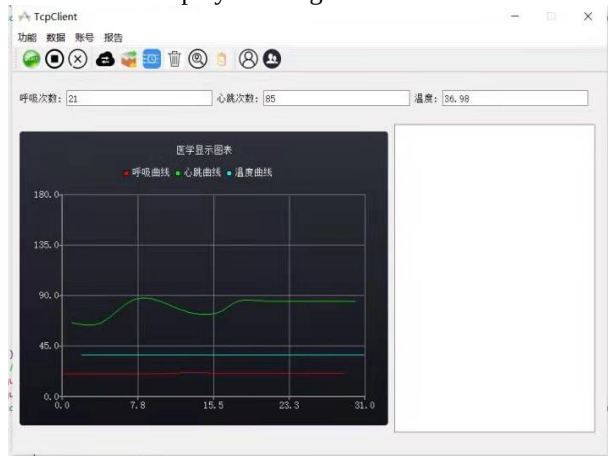


Figure 3. The demonstration of the results



Figure 4. The remind information

IV. DISCUSSION

The accurate computations of breath and heart rates are interfered by the noise. Therefore, some de-noise techniques is necessary to be employed in the system. In this study, BP algorithm was embedded in the microcontroller for de-noising. The advantages of the design are as follows,

- The heart and breath rates are mainly regular, so that the BP algorithm can cancel the noise accurately.
- The data communication volume between cloud and client can be much reduced, because the raw data has been converted to breath and heart rates. However, the data communication is not always free charge. Reduction of the communication volume is necessary on the point of business or green energy views.

Based on the preliminary model in this study, we can add the other sensors to increase the functions of this system, and will expect to the cooperation in hospitals.

V. CONCLUSION

This study presented the distant healthcare of the basic physiological signals. The preliminary system can be added functions for increasing monitoring of the physiological signals. Because the raw data has been converted, the communication volume between client and cloud can be much reduced, and this technology can be employed for the other physiological signals to elevate the performance of this system in the near future.

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Mei Liu received her BS in Measurement and Control Technology and Instrument from Tianjin University in 1990, MS and PhD in Control Theory and Control Engineering from South China University of Technology in 2004 and 2010. She is currently a professor and the Director of the Academic Affairs Office at Guangdong University of Petrochemical Technology, Maoming City, Guangdong, China. Her academic interests focus on control theory and control engineering, including intelligent detection and intelligent control algorithm and technology.



Ankang Lin is a student with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China. He has received the excellent student award in the faculty. He is the selected candidate of 2021 student competition of innovation design for biomedical engineering, China. His interests of research fields are coding and cloud computing.



Rushan Wu is a student with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China. She has received the scholarship which is supported by the university. She is the selected candidate of 2021 student competition of innovation design for biomedical engineering, China. His interests of research fields are FPGA, and sensors.



Sen Liu is a student with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China. He is the selected candidate of 2021 student competition of innovation design for biomedical engineering, China. His interests of research fields are microprocessor applications, and sensors.



Gaowei Lei received his BS in electrical information engineering from Shangqiu Normal University in 2011, MS in control engineering from Taiyuan University of Technology in 2014. He is currently a lecturer with Faculty of Automation, Guangdong University of Petrochemical Technology, Maoming City, Guangdong, China. His academic interests focus on artificial intelligence and fault diagnosis.



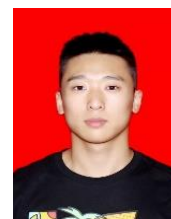
Junzhi Lu received his BS in automation from XIDIAN University in 2005, MS in control theory and control engineering from XIDIAN University in 2008. He is currently a teacher with Faculty of Automation, Guangdong University of Petrochemical Technology, Maoming City, Guangdong, China. He was an instructor with Department of Guangdong University of Petrochemical Technology, Maoming City, China during 2010 to 2021. His academic interests focus on microcontroller applications, embedded system applications and intelligent control.



Man Xie received her BS in Industrial Electrical Automation from Xi'an Shiyou University in 1994, and MS in Control Engineering from South China University of Technology in 2005. She is currently an instructor with Faculty of Automation, Guangdong University of Petrochemical, Guangdong, China. Her academic interests focus on electrical engineering and Power Electronics.



Pao-An Lin received his BS degree in physics from National Tsing Hua University and his MS and PhD degrees in physics from National Tsing Hua University in Taiwan in 1997, 1999, and 2006, respectively. He was an instructor at the Department of Physics, National Tsing Hua University, and served as a post-doctor in academia sinica, Taiwan during 2006-2012. He also joint department of physics in University of Illinois at Urbana-Champaign (UIUC) as a visitor scholar, 2009. He served as a Researcher in CMS, ITRI, Taiwan since 2014. He is currently an associate professor with Faculty and Department of Physics, Guangdong University of Petrochemical Technology, Guangdong, China. His academic interest is condensed matter physics, especially on superconductivity, multiferroics, and topological insulator



Junbai Wu is a student with Faculty of Automation, Guangdong University of Petrochemical Technology, Guangdong, China. He is the member and winner of the student competition of innovation and creation proposal in Faculty of Automation, Guangdong University of Petrochemical Technology. His interests of research fields are IoT, and embedded system.



Bing-Yuh Lu received his BS in electrical engineering from National Central University in 1988, MS in electrical engineering from National Taiwan University in 1993, and PhD in electrical engineering from National Taiwan University in 2000. He is currently a professor with Faculty of Automation, Guangdong University of Petrochemical Technology, Maoming City, Guangdong, China. He has been an instructor, associate professor, and full professor with Department of Electronic Engineering, Tunghua University, New Taipei City, Taiwan during 1993 to 2019. He is a member of IEEE. His academic interests focus on acoustics, medical engineering and pulmonary signal processing.

