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A Review on Wearble Wireless Physiological Monitoring System Based On Body Sensor

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ABSTRACT

The purpose of wearable technology is to use multimedia, sensors, and wireless communication to integrate specific technology into user clothes or accessories. With the help of various sensors, the physiological monitoring system can collect, process, and transmit physiological signals without causing damage. Wearable technology has been widely used in patient monitoring and people's health management because of its low-load, mobile, and easy-to-use characteristics, and it supports long-term continuous work and can carry out wireless transmissions. In this paper, we established a Wi-Fi-based physiological monitoring system that can accurately measure heart rate, body surface temperature, and motion data and can quickly detect and alert the user about abnormal heart rates

1. INTRODUCTION

In recent years, with economic and social development, people's health has been constantly threatened by various factors. For example, cardiovascular disease has remained the main cause of disease burden in the world in recent years. According to surveys, as of 2019, the number of global cardiovascular disease cases had reached 523 million and the death toll had reached 18.6 million. In most countries, cardiovascular disease has continued to increase for decades . At the same time, the medical system is facing challenges. For example, as medical costs rise, the affordability of medical expenses has become an important topic and there are conflicts between medical resources and medical needs. From the perspective of highly hidden and harmful diseases such as cardiovascular diseases, health monitoring is very important in modern society and can reduce risks to health and reduce burden on the medical system. In the field of health monitoring, Internet of Things technology has become a very important technology and there has been some work to analyse the factors that affect the design of the Internet of Things. With the improvement of technologies such as the Internet of Things, the related costs of health monitoring continue to decrease and wearable devices have become a reliable tool for health monitoring. Users now mainly obtain wearable devices through online purchases, and such devices are continuously popularized and developed through online channels. Because of the portability of wearable devices, they play an increasingly important role in long-term health monitoring. For example, smart watches have some technical and psychological characteristics and are already a widely used mobile health communication tool. From the current point of view, it is an important development direction for wearable devices to concentrate multiple sensing tasks on a single device and to realize comprehensive monitoring of multiple data.

Wearable devices rely on various sensors to collect bodily and environmental data, to conduct comprehensive analysis of the data, and to transmit the required information to the master computer through communication. These tasks can carry out effective physiological monitoring to achieve disease prevention and to reduce medical burden. Currently, in the field of wearable devices, there are related work on monitoring different types of data.

Chételat et al.designed a new system to monitor large sets of physiological, kinetics, and environmental parameters. Moreover, the system they designed is easy to disassemble when the clothes need to be washed. Jun Liu et al. Presented a long-term monitoring system based on multi-sensors. The data are transmitted via Bluetooth but may not meet the sampling rate requirements. Wasimuddin et al. proposed an improved method based on CNN, which can identify the type of arrhythmia in real time based on ECG waves, and it is also adaptable in wearable systems. Jung et al. proposed a new method to monitor ECG with two wireless modules. Cheng Cu et al. proposed a human motion tracking technology based on a hybrid approach of multiple sensors. James Coates et al. designed a wearable multi-sensor system that collects data including temperature, humidity, and galvanic skin response. The abovementioned wearable system designs have limitations in different aspects. For example, data-processing algorithms that rely on models have difficulty in obtaining labeled data; digital–analog hybrid systems may be affected by noise; and some devices have limitations in long-term monitoring tasks.

We designed a wearable physiological monitoring system based on Wi-Fi technology. Our device integrates ECG signal sensors, temperature sensors, and motion sensors, which can perform real-time monitoring of the wearer's ECG, body temperature, movement acceleration, etc. The system uses algorithms to process data in the MCU and sends the information to the PC or the cloud via Wi-Fi for processing and display. The system realizes long-term and reliable monitoring of physiological signals through the wearable device, and we use low-power devices to implement hardware design to optimize the overall power consumption of the system.

We can briefly summarize the main contributions of the current research as follows:

2. DISCUSSION

This section describes the design of the wearable wireless physiological monitoring system that can monitor the user's ECG, motion data, and body surface temperature. As depicted in, the system is composed of several sensors and a main controller for the purpose of monitoring.

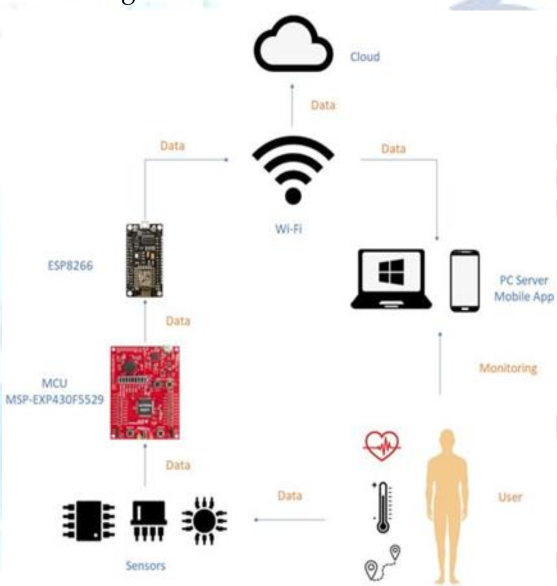


Figure 1. The architecture of the wireless physiological monitoring system.

The monitoring system uses MSP-EXP430F5529 (Dallas, TX, USA)as a microcontroller, and the sensor includes an ECG signal sensor, a body surface temperature sensor, and a motion sensor. We used a Wi-Fi module for wireless data transmission. At the same time, the collected data are displayed on the PC interface in real time and uploaded to the cloud data platform.

The system workflow is as follows: After initialization, the MSP430 (Dallas, TX, USA) microcontroller first sends the corresponding information to the Wi-Fi module to complete the network connection between the Wi-Fi module and the PC or mobile phone terminal. Each sensor is directly connected to the MSP-EXP430F5529 microcontroller.

According to the circuit design, the sensor adopts an UART/SPI/I2C protocol in communication with the microcontroller. Each sensor is used to measure specific parameters (ECG data, temperature data, and motion data). The sensors continue to collect data and to send the data they collect to the microcontroller in real time. The MSP430 microcontroller packs the data according to the agreed upon rules, and the Wi-Fi module sends data frames to the PC or mobile phone and uploads them to the cloudks the data according to the agreed upon rules, and the Wi-Fi module sends data frames to the PC or mobile phone and uploads them to the cloud.

The hardware of the system includes a microcontroller, a Wi-Fi module, an ECG signal sensor module, a temperature sensor module, and a motion sensor module.

The microcontroller receives data continuously sent by the sensor, encapsulates the data into a data frame, and then sends the encapsulated data frame to the Wi-Fi module for data transmission. We chose MSP-EXP430F5529 as the microcontroller for the system. This microcontroller is produced by TI and uses the MSP430F5529 chip. MSP430F5529 is the latest generation of ultralow-power single-chip microcomputers with an integrated USB, can be applied to tasks such as wireless sensing, and is one of the single-chip microcomputers with the lowest working power consumption. The ultralow power-consumption characteristics of MSP430F5529 and the multiple peripherals integrated by the single-chip microcomputer are suitable for this system and provide the possibility for future improvements.

The Wi-Fi module is used to send the data frames generated by the microcontroller to a PC or mobile phone terminal and uploads the data to the cloud. We chose ESP8266 (Shanghai, China), which is produced by Espressif company, as the Wi-Fi module in the system. ESP8266 is a high-performance UART-WiFi module. The module uses a serial port (LVTTL) to communicate with the MCU (or other serial devices) and has a built-in TCP/IP protocol stack, which can convert between serial ports and Wi-Fi. In this system, MSP430F5529 completes initialization and data transmission of ESP8266 through AT commands. In this local area network, we set ESP8266 to STA mode and the PC or mobile phone terminal to AP mode. The TCP protocol is used for communication between the STA and the AP. After MSP430F5529 receives the data from the sensors, it packs the data into a data frame according to a certain format, which includes sensor data and a data header for verification. ESP8266 will immediately send the data through Wi-Fi after receiving the data from the serial port.

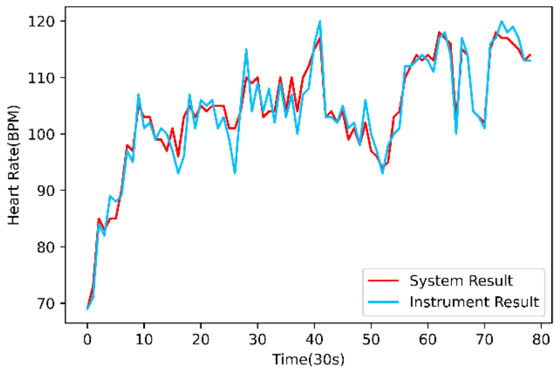
The peak value of the ECG signal is about 1 mv, and the internal noise of the human body is a type of interference to the detection of low-frequency and low-amplitude ECG signals. Therefore, an analog front end with high gain and low cutoff frequency is essential for back-end digital conversion and processing of the ECG signal. We used TI's ADS1292 (Dallas, TX, USA) analog front end, which has two low-noise PGAs and two high-resolution ADCs inside. It has an SPI interface. The quiescent current is 20 μA and the shutdown current is less than 1 μA. It contains all of the functions usually required for portable low-power medical ECG applications and is suitable for low-power and high-precision ECG measurement tasks. The hardware circuit of the ECG signal sensor module based on ADS1292 is shown in .The module uses ADS1292 as the core chip and AP2112K (Shanghai, China) as the voltage regulator chip, which converts 5 V voltage to 3.3 V to power the module. At the same time, it uses TXS0108E as the conversion chip of the logic level.

3. METHODOLOGY

The use process of the physiological monitoring system is as follows: connect the system to a 5 V power supply, the MCU automatically initializes after powering on and automatically sets the network parameters for the Wi-Fi module. After the MCU confirms that the network is correctly connected, sampling is performed, and the data sent by each sensor are processed and packaged. The user sticks the three-terminal lead of the ECG signal sensor in the correct position on the body, places the temperature sensor on the wrist, and then fixes the motion sensor on the waist. As shown in figure, after the system is properly initialized, the terminal interface will display the user's relevant information in real time. Implementation of our system on a subject is shown.

When measuring the actual ECG signal, we let the subjects exercise at a certain intensity to continuously increase their heart rate. At the same time, we used the finger clip heart rate measuring instrument and the monitoring system designed in this paper to record the tester's heart rate.

The figure shows the results measured by a subject using a finger clip heart rate tester and the detection system designed in this paper. During the test, the subject's heart rate continued to rise and fluctuated to a certain extent. analyzes the result analysis of the tester and the detection system of this paper. The correlation coefficient of the two equipment detection results is 0.969, the maximum absolute error is 8 BPM, and the absolute error range is 1.924 ± 1.540 BPM. The system design can be seen from the results. The accuracy meets the needs of daily use, indicating that the system is effective and reliable.



4. CONCLUSION

In this paper, we proposed a physiological monitoring system based on multiple sensors. The system can monitor a variety of physiological signals in the human body and can display the collected physiological signals on the terminal in real time. By comparing the system with a standard medical monitor, the accuracy and feasibility of the system are verified. In the temperature data measurement, we performed polynomial fitting correction on the output voltage of the LMT70 to make the temperature module more accurate in the body surface temperature range; in the ECG signal measurement, we collected the bioelectric signal with the ADS1292 chip as the core. The collected ECG signals were processed to reduce the interference of baseline drift on the ECG waveform. The results show that our heart rate test results are very close to medical equipment, and an alarm can be presented when the subject's heart rate is too high or too low; in the motion data measurement, we used the acceleration and angular velocity data returned by the MPU6050 to calculate the pose and to calculate the distance and the number of steps. At the same time, we tested the power consumption of the system in the case of continuous data transmission and reception. The total current of the system was about 83 mA. When the Wi-Fi module was turned off, the total power consumption of the system was about 15 mA, which meets the requirements of low power consumption. In future research, we will try to improve the portability of the entire system, to integrate other sensors, and to reduce the circuit volume of the existing system. We tried to perform further analysis based on the returned physiological signals, such as monitoring cardiovascular diseases based on the abnormal part of the ECG waveform.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Goldberg, Neal & Rodriguez-Prado, Yahdira & Tillery, Rebecca & Chua, Caroline. (2018). Wearable wireless physiological monitoring through body sensor. 47. e118-e123. 10.3928/19382359-20180221-03.

[2] Moon RY; information tailoring about monitoring physiological bodyparameters2016 Nov; 138(5):e20162940. doe: 10.1542/peds.2016-2940. PMID: 27940805.

[3] Gilbert R, Salanti G, Harden M, See S. Physiological monitoring through body sensor. from 1940 to 2002. Int J Epidemiology. 2005 Aug;34(4):874-87. doi: 10.1093/ije/dyi088. Epub 2005 Apr 20. PMID: 15843394.

[4] Kim H, Pearson-Shaver AL. Effect of Online Product Presentation on the Purchase Intention of Wearable Devices: The Role of Mental Imagery and Individualism–Collectivism. Front. Psychol. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan

[5] Wu Q, Qin P, Kuang J, Wei F, Li Z, Bian R, Han C, Xu G. An acceptance model for smart watches: Implications for the adoption of future wearable technology. Internet Res. Electron Videos. IEEE Trans Neural Syst Rehabil Eng. 2023;31:1670-1679. doi: 10.1109/TNSRE.2023.3255639. PMID: 37028311.

[6] Gomez DA, Charpak N, Montealegre A, Hernandez JT. VALS: Supporting Visual Data Analysis in Longitudinal Clinical Studies. IEEE Access. 2023;11:28820-28830. doi: 10.1109/ACCESS.2023.3259972

[7] Perrone S, Lembo C, Moretti S, Prezioso G, Buonocore G, Toscani G, Marinelli F, Nonnis-Marzano F, Esposito S.Single body sensor: Beyond Risk Factors. Life (Basel). 2021 Feb 26;11(3):184. doi: 10.3390/life11030184. PMID: 33652660; PMCID: PMC7996806.

[8] Kim H, Pearson-Shaver AL. Sudden Cardiovascular disease. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan

[9] Peng Z, Varisco G, Long X, Liang RH, Kommers D, Cottaar W, Andriessen P, van Pul C. A Continuous Late-Onset Sepsis Prediction Algorithm for Preterm Infants Using Multi-Channel Physiological Signals From a Patient Monitor. IEEE J Biomed Health Inform. 2023 Jan;27(1):550-561.doi:10.1109/JBHI.2022.3216055. Epub 2023 Jan 4. PMID: 36264730.

[10] Goldwater PN. Monitoring physiological parameters using sensors. 2017 Nov 14;5:223. doi: 10.3389/fped.2017.00223. PMID: 29184885; PMCID: PMC5694444.

[11] Jullien S. Monitoring physiological parameters using sensors. 2021 Sep 8;21(Suppl 1):320. doi: 10.1186/s12887-021-02536-z. PMID: 34496779; PMCID: PMC8424793.

[12] Moon, Rachel Y., et al. "Sleep-related infant deaths: updated 2022 recommendations for reducing infant deaths in the Monitoring physiological parameters using sensors 150.1 (2022).

[13] M.H. Vigne, M. Moreau, G. Gascoin, E. Darviot, Descriptive analysis of Monitoring physiological parameters using sensors, Volume 30, Issue 5, 2023, Pages 271-276, ISSN 0929-693X, https://doi.org/10.1016/j.arcped.2023.02.006

[14] Batra, E. K., Lewis, M., Saravana, D., Corr, T. E., Daymont, C., Miller, J. R., & Fogel, B. N. (2021). Improving hospital infant safe sleep compliance by using safety prevention. Monitoring physiological parameters using sensors 148(6), e2020033704.

[15] Mehboob, R., Kurdi, M., Ahmad, M., Gilani, S. A., Khalid, S., Nasief, H., ... & Shahzad, S. A. (2021). Comprehensive analysis of. Monitoring physiological parameters using sensors 9, 742225.

[16] Carmel Therese Harrington, Naz Al Hafid, Karen Ann Waters. Monitoring physiological parameters using sensors, Volume 80, 2022, 104041, ISSN 2352-3964,https://doi.org/10.1016/j.ebiom.2022.104041.

[17] National Institute of Justice, "Scientists Seek Connection. Monitoring physiological parameters using sensors," December 16, 2021,

[18] Emma Matthews, Refocusing SIDS research:. Monitoring physiological parameters using sensors? VOLUME 81, 104104, JULY 2022 DOI:

[19] Glinge C, Rossetti S, Oestergaard LB, et al. . Monitoring physiological parameters using sensors. JAMA Netw Open. 2023;6(1):e2252724. doi:10.1001/jamanetworkopen.2022.52724

[20] Ferreira, Andre & Fernandes, Duarte & Branco, Sérgio & Monteiro, João & Cabral, Jorge & Algoritmi, Centro & Catarino, André & Rocha, A.. (2016). A Smart Wearable System for Sudden Infant Death Syndrome Monitoring.10.1109/ICIT.2016.7475060.

[21] Duncan JR, Byard RW. In: Duncan JR, Byard RW, editors. SIDS Sudden. Monitoring physiological parameters using sensors. Adelaide (AU): University of Adelaide Press; 2018

[22]