Smart Blood Pressure Monitoring System Based on Internet of Things

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Abstract  
At present, home electronic blood pressure monitor has many problems, such as the data errors and lack of smart solutions. This paper aims at putting forward a brand new solution—smart blood pressure monitoring system based on Internet of Things, which is characterized by three aspects. A) Monitor side: by the use of the Internet of Things, smart blood pressure monitor measures the user’s blood pressure along with other blood pressure monitors in operation at the server-side to ensure data accuracy. B) User side: with smart solutions, users can use the electronic blood pressure monitor to measure, record and send the data to data processing center for storage. C) Doctor side: doctor workstation may monitor users’ blood pressure in real time, and give warnings or advices. The application of the Internet of Things in smart blood pressure monitoring will improve its accuracy and credibility significantly, as well as benefit the development of medical technology.

Author Keywords  
Internet of Things; electronic blood pressure monitor; intelligent medical treatment; home interactive medical devices.

ACM Classification Keywords  
J.3. Life and Medical Sciences; H.3.5 [Online information services]: web-based services.
Introduction
The blood pressure, an important physiological parameter of the human body, is also a vital indicator in clinical care and even daily health care. In the modern society with rich material lives, high blood rate is continuously increasing. At the same time, people attach more and more importance to their health and hope that they can know their health conditions at any time for preventing various diseases. Therefore, safe and simple-to-use blood pressure monitors become common home blood pressure measuring tools [1].

Currently, two common kinds of blood pressure monitors in the market are mercury column blood pressure gauge and electronic blood pressure monitor. This paper focuses on electronic blood pressure monitor.

Background
The traditional electronic blood pressure monitor uses electronic pressure and pulsating sensor to identify signal of pressure and pulsation, and display the signal in digital form. The top of the screen is the systolic blood pressure, and the lower part shows the diastolic blood pressure and pulse rate[4]. It has many advantages: it is simple to operate that one only need to click on the button, it will automatically measure, and it has intuitive readings, which is suitable for home use. However, the traditional electronic blood pressure monitor also has its drawbacks, mainly reflected in the following three aspects:

A. Data errors:
- Because of the lack of a unified standard, different types and different brands of electronic blood pressure monitors have different blood pressure measurement scope and have user population differences when applying.
- The inaccuracy of measurement led by the data errors. The electronic blood pressure monitor has data errors when measuring static pressure for that the pressure data collected by the pressure sensor have to go through repeated signal conversion and processing, in this process, it certainly will cause errors[5].
- Since there’s an increase of length of time and frequency of use, the pneumatic pump of the electronic blood pressure monitor may lose efficacy, which resulted in larger measurement error.

B. Lack of a complete intelligent system
- The traditional electronic blood pressure monitor cannot analyze the data and transmit the data.
Because of the lack of data sharing and remote medical assistance, doctors cannot observe the measurement of patients remotely, so that a reminder of the situation or suggestions cannot be given in time.

There’s no digitized health management platform.

Therefore, when using the blood pressure monitor, the user would has the concern that if the blood pressure monitor is normal or if the data is accurate [6]. The traditional solution for it is to go to the hospital to do the correction from time to time. Users have to waste time on registering and queuing in the hospital each time. It greatly affects the user experience.

The Solution
To solve the problems above, the following will propose a new solution — the intelligent blood pressure monitoring system based on the Internet of Things.

The intelligent blood pressure monitoring system (see Figure 1) is composed of intelligent electronic blood pressure monitor, data processing center, doctor workstation, and communication facilities.

![Intelligent electronic blood pressure monitor](image)

Added the networking capabilities on the basis of the traditional electronic blood pressure monitor, it (see Figure 2) can be connected via Bluetooth or WLAN technology to the Internet. In the measurement process, it can transmit the real-time measured data (i.e., pulse wave) to the data processing center, and have the functions of storing, recording and displaying the blood pressure data as well as receiving system abnormalities reminders and doctors’ suggestions.

![Figure 2. The intelligent electronic blood pressure monitor.](image)

Data processing center
The data processing center can receive the data (i.e., pulse wave) transmitted from user’s blood pressure monitor in real-time, and at the same time, some normal blood pressure monitors at the data processing center will measure this same user's blood pressure together. Then, the data processing center will analyze the data that measured by user's blood pressure monitor and the data measured by the data processing center. When estimating the values, if the values are within the normal range which indicates that the user’s blood pressure monitor is normal, the data processing center will send the mean blood pressure value of all
the blood pressure monitors to the intelligent electronic blood pressure monitor. While, if the values are not within the normal range, indicating that the user’s blood pressure monitor is abnormal, the data processing center will send a reminder of warning to the user’s blood pressure monitor. This method helps to ensure data accuracy.

**Doctor workstation**
The doctor workstation can also see the real-time blood pressure data of users, and therefore to set up a personal database for each user. Thus, the intelligent blood pressure monitoring system alerts users with abnormal blood pressure at any time and gives disposal proposals.

**Conclusion and future research**
The intelligent blood pressure monitoring system based on the Internet of Things put forward in this paper not only solve the problem of users’ concern of the accuracy of their blood pressure monitors, but also set up an intelligent health management platform. Therefore, this system has such a wide applicability that it can be applied not only in blood pressure monitoring, but also can be extended to the field of EEG, ECG, blood sugar, breathing monitoring. Because the primary goal of this paper is to design a new solution, we do not focus our time on implementing complete system. We are confident that all of our ideas are possible given the current technology. By the using of the modern communication facilities, this system provides patients with convenient medical channels, and largely improves their medical treatment experience; and also the medical institutions will obtain vast amounts of clinical data, this will make great contribution to the development of medical technology and the raising people’s health level.

**Acknowledgements**
This study is partly supported by the National Natural Science Foundation of China (61070075, 61004116, 61003147), Major Program of Science and Technology of Zhejiang Province (2011C14018) and Program of Industrial, Education and Research Combination of Ministry of Education of Guangdong Province (2011B090400503).

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