

BLOOD PRESSURE MEASURING DEVICE AND BLOOD PRESSURE MEASURING METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the invention

5 The embodiment of the present invention relates to a blood pressure measuring device and a blood pressure measuring method thereof, particularly, to a blood pressure measuring device and method suitable for different types of blood pressure cuffs and different test subjects.

2. Description of the prior art

10 Currently, blood pressure measuring devices are unable to automatically adjust the corresponding blood pressure measurement mode for different types of blood pressure cuffs. Instead, the blood pressure measuring devices of the prior art require pre-settings such as "child mode" or "adult mode," and must be equipped with blood pressure cuffs specifically sized for children or adults to avoid injury from the test
15 subject or measurement inaccuracies.

 However, providing a blood pressure measuring device that can automatically identify and adapt to different types of blood pressure cuffs and different test subjects would make the device more convenient and safe to use.

SUMMARY OF THE INVENTION

20 Therefore, the present invention provides a blood pressure measuring device. The blood pressure measuring device includes an air pump, an air release valve with constant speed, and a control circuit. The air pump is connected to a blood pressure cuff. The air release valve with constant speed is connected to the blood pressure cuff. The control circuit is connected to the air pump. When the control circuit determines
25 that the pressure relief time length of the blood pressure cuff should be adjusted

according to the initial pressurization time length, the control circuit is configured to control the air pump to inflate the blood pressure cuff, while the air release valve with constant speed deflating the blood pressure cuff, so as to adjust the pressure relief time length of the blood pressure cuff. The initial pressurization time length is the
5 time length during which the air pump inflates the blood pressure cuff to a preset pressure value at an initial pressurization rate.

The present invention provides a blood pressure measuring method, which is apply for the blood pressure measuring device. The blood pressure measuring device includes an air pump, an air release valve with constant speed, and a control circuit.
10 The blood pressure measuring method comprising the following steps of: during an initial operation, inflating a blood pressure cuff to an preset pressure value by the air pump at an initial pressurization rate, and obtaining an initial pressurization time length by the control circuit; determining whether to adjust a pressure relief time length of the blood pressure cuff according to the initial pressurization time length by
15 the control circuit; and when determining that the pressure relief time length needs to be adjusted, during the measurement operation, while the air release valve with constant speed is releasing air from the blood pressure cuff, controlling the air pump to inflate the blood pressure cuff to adjust the pressure relief time length by the control circuit.

20 In order to make the features and advantages of the present invention more apparent and understandable, the following detailed description is provided along with the appended drawings, illustrated through specific embodiments.

BRIEF DESCRIPTION OF THE APPENDED DRAWINGS

25 In order to make the above and other purposes, features, advantages, and embodiments of the present disclosure more apparent and understandable, the description of the accompanying drawings is as follows:

FIG. 1 is a schematic diagram illustrating the blood pressure measuring device according to some embodiments of the present invention.

FIG. 2 is a flow chart illustrating the blood pressure measuring method according to some embodiments of the present invention.

FIG. 3 is an experimental data diagram illustrating operation of the blood pressure measuring device according to some embodiments of the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

In the detailed description of the invention, the "coupling" can also refer to "electrical coupling," and the "connection" can also refer to "electrical connection." Moreover, "coupling" and "connection" can also refer to the mutual coordination or interaction between two or more components.

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Please refer to FIG. 1. FIG. 1 is a schematic diagram illustrating the blood pressure measuring device 100 according to some embodiments of the present invention.

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As shown in FIG. 1, the blood pressure measuring device 100 includes a control circuit 110, an air pump 130, an air release valve with constant speed 150, and a quick release valve 170. In terms of connectivity, the control circuit 110 is connected to the quick release valve 170, and the control circuit 110 is also connected to the air pump 130. The control circuit 110, air pump 130, air release valve with constant speed 150, and quick release valve 170 are all connected to the blood pressure cuff 900.

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As shown in FIG. 1, in some embodiments, the control circuit 110 includes a control chip 112, a pressure sensing circuit 114, a filtering circuit 116, and a Bluetooth communication circuit 118. In terms of connectivity, the pressure sensing circuit 114 is connected to the filtering circuit 116, the filtering circuit 116 is connected to the control chip 112, and the control chip 112 is connected to the Bluetooth communication circuit 118. The pressure sensing circuit 114 is also connected to the blood pressure cuff 900. The control chip 112 is also connected to the air pump 130 and the quick release valve 170.

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Please refer to FIG. 2. FIG. 2 is a flow chart illustrating the blood pressure measuring method 200 according to some embodiments of the present invention. The blood pressure measuring method 200 can be performed by the blood pressure

measuring device 100 shown in FIG. 1. The blood pressure measuring method 200 includes step S210 to step S250.

In step S210, during an initial operation, the air pump inflating a blood pressure cuff to a preset pressure value at an initial pressurization rate, and the control circuit obtaining an initial pressurization time length. Please also refer to FIG. 1. Step S210 can be performed by the air pump 130 and the control circuit 110 as shown in FIG. 1.

Please also refer to FIG. 1. During the initial operation, the air pump 130 inflates the blood pressure cuff 900 at the initial pressurization rate until the pressure value of the blood pressure cuff 900 increases from 0 to the preset pressure value, or inflates the blood pressure cuff 900 at the initial pressurization rate until the pressure value of the blood pressure cuff 900 reaches 80% to 90% of the preset pressure value, which the initial pressurization time length is obtained by the control circuit 110. In some embodiments, the initial pressurization rate is the maximum pressurization rate or an upper limit of the maximum pressurization rate, but the embodiments of the present invention are not limited hereto.

For example, please also refer to FIG. 3. FIG. 3 is an experimental data diagram 300 illustrating operation of the blood pressure measuring device shown in Figure 1 according to some embodiments of the present invention. In the experimental data diagram 300 shown in FIG. 3, the horizontal axis represents time (t), and the vertical axis represents the pressure value of the blood pressure cuff 900 as shown in FIG. 1. As shown in FIG. 3, curve C1 represents the experimental data of the initial operation; point D1 on curve C1 represents the initial pressurization time length T1 when the blood pressure cuff 900 reaches the preset pressure value P1 during the initial operation.

Wherein, the preset pressure value P1 can be 140 mmHg, 150 mmHg, or 160 mmHg, and the initial pressurization time length T1 can be 5.5 seconds, 6 seconds, or 6.5 seconds. However, the values of the embodiments of the present invention are not limited hereto.

Next, as curve C1 in FIG. 3, during the initial operation, when the air pump 130 inflates the blood pressure cuff 900 at the initial pressurization rate until the pressure value of the blood pressure cuff 900 reaches the preset pressure value, and then the

quick release valve 170 deflates the air from the blood pressure cuff 900 to reduce the pressure value of the blood pressure cuff 900 to 0, which is completing the determination of the type of the blood pressure cuff or the test subject.

5 In step S230, the control circuit determining whether to adjust a pressure relief time length of the blood pressure cuff according to the initial pressurization time length. Please also refer to FIG. 1. Step S230 can be performed by the control circuit 110 as shown in FIG. 1.

10 In step S230, when the initial pressurization time length is less than or greater than a reference value of the pressurization time length, or when the initial pressurization time length is less than or greater than 1.05% to 1.15% of the reference value of the pressurization time length, the control circuit 110 determining whether to adjust at least one of the pressurization time length and the pressure relief time length of the blood pressure cuff 900.

15 In some cases, when the initial pressurization time length is less than or greater than a reference value of the pressurization time length, the control circuit 110 further determines whether to adjust at least one of the initial pressurization time length and the pressure relief time length. Specifically, if the reference value between the initial pressurization time length and the pressurization time length is different or does not match, the control circuit 110 determines that the blood pressure measuring mode of
20 the blood pressure measuring device 100 needs to be changed or added. After changing or adding the blood pressure measuring mode, the reference value of the initial pressurization time length will also be adjusted to a value corresponding to the changed or added blood pressure measuring mode.

25 For example, if the blood pressure measuring device 100 has a blood pressure measurement mode including an adult mode (L size) and a child mode, where the reference value of the initial pressurization time length in the adult mode (L size) is 10 seconds, and the reference value of the initial pressurization time length in the child mode is 5 seconds. If during the initial operation in step S210, the blood pressure measurement mode of the blood pressure measuring device 100 is preset to the adult
30 mode (L size) and the initial pressurization time length obtained by the control circuit 110 is 5 seconds, the control circuit 110 will adjust the blood pressure measurement

mode of the blood pressure measuring device 100 to the child mode and adjust the reference value of the initial pressurization time length to 5 seconds.

5 In another example, during the initial operation in step S210, the blood pressure measurement mode of the blood pressure measuring device 100 is preset to the adult mode (L size) and the initial pressurization time length obtained by the control circuit 110 is 7 seconds, the control circuit 110 will add a new blood pressure measurement mode for the adult mode (M size) according to the initial pressurization time length and adjust the reference value of the initial pressurization time length to 7 seconds.

10 In step S250, when the control circuit determining that the pressure relief time length needs to be adjusted, during the measurement operation, while the air release valve with constant speed is releasing air from the blood pressure cuff, the control circuit controlling the air pump to inflate the blood pressure cuff to adjust the pressure relief time length. Step S250 can be performed by the control circuit 110, air pump 130, and air release valve with constant speed 150 as shown in FIG. 1.

15 When determines the pressure relief time length needs to be adjusted, the control circuit 110 inputs an adjustment current to the air pump 130 according to the adjustment current, the air pump 130 inflates the blood pressure cuff 900 at the adjustment current, while the adjustment current is deflating the blood pressure cuff, thereby reducing the pressure relief rate and thus lengthening the pressure relief time
20 length.

Suppose that during the initial operation, the air pump 130 receives the initial pressurization current from the control circuit 110 to inflate the blood pressure cuff 900 at the initial pressurization rate. In step S250, during the measurement operation, while the air release valve with constant speed 150 is releasing air, the control circuit
25 110 inputs the adjustment current to the air pump 130 that is 3% to 20% of the initial pressurization current, for example: 3%, 5%, 8%, 10%, or 12%. The adjustment current is for illustrative purposes only and is not limited to these values in the implementation of this case.

30 If in step S230, the control circuit 110 determining that the pressurization time length of the blood pressure cuff 900 needs to be adjusted, and then in step S250, the control circuit 110 also determining that the pressurization rate of the blood pressure

cuff 900 needs to be adjusted. During the measurement operation, the control circuit 110 adjusting the pressurization rate to ensure that the pressurization time length is not less than the reference value of the pressurization time length.

5 Suppose that during the initial operation, the air pump 130 receives the initial pressurization current from the control circuit 110 to inflate the blood pressure cuff 900 at the initial pressurization rate. In step S250, during the measurement operation, the control circuit 110 inputting the pressurization current to the air pump 130 is 40% to 80% of the initial pressurization current, for example: 45%, 50%, 55%, 60%, or 70%. The pressurization current is for illustrative purposes only and is not limited to
10 these values in the implementation of this case.

Please also refer to FIG. 3. Curve C2 in FIG. 3 represents the experimental data of the measurement operation where the pressurization time length was adjusted but the pressure relief time length was not. Curve C3 in FIG. 3 represents the experimental data of the measurement operation where both the pressurization time length and the
15 pressure relief time length were adjusted.

Both curve C2 and curve C3 include point D2, which represents the pressurization time length T2 when the blood pressure cuff 900 reaches the measured pressure value P2. In some embodiments, the measured pressure value P2 can be the same as or close to the preset pressure value P1, or can correspond to the preset
20 pressure value depending on the adjusted blood pressure measurement mode. In some embodiments, when the difference between the measured pressure value P2 and the preset pressure value P1 is within a difference threshold, the measured pressure value P2 is considered close to the preset pressure value P1. In some embodiments, the difference threshold is between 10% and 15% of the preset pressure value P1. The
25 difference threshold is for illustrative purposes only and is not limited to these values in the embodiments.

The adjusted pressurization time length T2 is twice the initial pressurization time length T1, while the adjusted pressure relief time length T3 (the time length for the blood pressure cuff 900 to decrease from the measured pressure value P2 to 0) can be
30 three, four, or five times the initial pressurization time length T1. In some embodiments, the adjusted pressurization time length T2 can be 10 ($\pm$ error value)

seconds, 11 seconds, 12 seconds, or 15 seconds. The adjusted pressurization time length T2 and the adjusted pressure relief time length T3 are for illustrative purposes only and are not limited to these values in the embodiments.

When the initial pressurization time length is less than the reference value of the pressurization time length, which indicates that the blood pressure cuff 900 is sized for a child or a small animal. Therefore, the control circuit 110 adjusts the pressurization time length and the pressure relief time length of the blood pressure cuff 900 to ensure that the pressurization rate of the blood pressure cuff 900 is not too fast to harm the subject. Moreover, by extending the pressure relief time length, more accurate blood pressure measurements can be obtained. This makes the operation safer and more accurate, and improves the user's experience during measuring the blood pressure.

On the other hand, if the initial pressurization time length is not less than the reference value of the pressurization time length, which indicates that the blood pressure cuff 900 is sized for an adult or a large animal. In this case, the control circuit 110 does not need to adjust the pressurization time length and the pressure relief time length of the blood pressure cuff 900 to perform the measurement. Alternatively, the control circuit 110 can adjust to shorten the pressurization time length and the pressure relief time length of the blood pressure cuff 900 to reduce the duration of the blood pressure measurement for the subject.

Thus, the blood pressure measuring device and the blood pressure measuring method described in this embodiment can automatically determine the type of blood pressure cuff or the type of subject, and adjust the pressure of the blood pressure cuff 900 by providing a small inflation flow by the air pump without changing the orifice diameter of the release valve. Thus, the pressure rise rate inside the small-sized blood pressure cuff can be controlled to prevent it from increasing too rapidly, thereby making the operation safer. Additionally, the pressure drop rate does not decrease too quickly which allow the blood pressure measuring device to obtain a sufficient signal interval for more accurate blood pressure values.

Additionally, the blood pressure measuring device and the blood pressure measuring method described in this embodiment can adapt to different subjects

without changing hardware components. Due to the variations in the thickness of the subject's limbs, even with the same initial pressurization rate, the initial pressurization time length of the blood pressure cuff 900 may differ. The embodiment of the present invention can adjust the pressurization time length and the pressure relief time length of the blood pressure cuff 900 to ensure safer use of the blood pressure measuring device under different subjects' conditions and to obtain more accurate blood pressure values.

Please refer back to FIG. 1. In some embodiments, the pressure sensing circuit 114 in FIG. 1 is used to sense the pressure value in the blood pressure cuff 900 and send the sensed pressure value (pressure waveform) to the filtering circuit 116. The filtering circuit 116 is used to filter the pressure value (pressure waveform) of the blood pressure cuff 900 sent from the pressure sensing circuit 114 and send the filtered pressure value (pressure waveform) to the control chip 112. The control chip 112 is used to analyze the pressure value of the blood pressure cuff 900 according to the filtered pressure value (pressure waveform) and perform steps S210 to S250 as described. The Bluetooth communication circuit 118 is used to transmit the measurement results or pressure values obtained by the control chip 112 to an electronic device (not shown) or a display device (not shown) for user operation or viewing.

The control circuit 110 can be a server, circuit, central processing unit (CPU), microcontroller (MCU), or other devices with similar functions that have capabilities such as storage, computation, data reading, signal or message reception, or message transmission. Various functional components are disclosed herein. For those skilled in the art, functional components can be implemented by circuits (whether dedicated circuits or general-purpose circuits operating under one or more processors and coded instructions).

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Although the disclosure has been described with embodiments, it is not intended

to limit the disclosure. Those skilled in the art can make various modifications and refinements without departing from the spirit and scope of the disclosure. Therefore, the scope of the disclosure should be defined by the claims appended hereto.

What is claimed is:

1. A blood pressure measuring device, comprising:
 - an air pump, connected to a blood pressure cuff;
 - an air release valve with constant speed, connected to the blood pressure cuff;
 - and
 - a control circuit, connected to the air pump, wherein when the control circuit determines that a pressure relief time length of the blood pressure cuff should be adjusted according to an initial pressurization time length, the control circuit is configured to control the air pump to inflate the blood pressure cuff, while the air release valve with constant speed deflating the blood pressure cuff, so as to adjust the pressure relief time length of the blood pressure cuff;
 - wherein, the initial pressurization time length is the time length during which the air pump inflates the blood pressure cuff to a preset pressure value at an initial pressurization rate.
2. The blood pressure measuring device of claim 1, wherein when the initial pressurization time length is less than or greater than a reference value of the pressurization time length, the control circuit is further configured to determine whether to adjust at least one of the initial pressurization time length and the pressure relief time length.
3. The blood pressure measuring device of claim 1, wherein the control circuit is further configured to determine whether to adjust a pressurization rate and a pressure relief rate of the blood pressure cuff when the initial pressurization time length is less than or greater than the reference value of the pressurization time length.
4. The blood pressure measuring device of claim 3, wherein the control circuit is further configured to adjust the pressurization rate so that a pressurization time length of the blood pressure cuff is not less than the reference value of the pressurization time length.
5. The blood pressure measuring device of claim 3, wherein the initial pressurization

rate corresponds to an initial pressurization current, the pressurization rate corresponds to a pressurization current, and the pressurization current is 40% to 80% of the initial pressurization current.

6. The blood pressure measuring device of claim 1, wherein when the control circuit determines that the pressure relief time length needs to be adjusted, the control circuit is further configured input an adjustment current to the air pump, so as to cause the air pump to inflate the blood pressure cuff according to the adjustment current while the air release valve with constant speed is deflating the blood pressure cuff;

wherein, the initial pressurization time length corresponds to an initial pressurization current, and the adjustment current is 3% to 20% of the initial pressurization current.

7. The blood pressure measuring device of claim 1, wherein when the initial pressurization time length is less than a reference value of the pressurization time length, the control circuit is further configured to determine to adjust the pressure relief time length and a pressurization time length of the blood pressure cuff, wherein the adjusted pressure relief time length is at least three times the adjusted pressurization time length.

8. The blood pressure measuring device of claim 1, further comprising:

a quick release valve, connected to the blood pressure cuff and the control circuit, wherein the quick release valve is configured to deflate the blood pressure cuff when the air pump inflates the blood pressure cuff at the initial pressurization rate and the blood pressure cuff reaches the initial pressurization time length.

9. A blood pressure measuring method, applying to a blood pressure measuring device, wherein the blood pressure measuring device comprises an air pump, an air release valve with constant speed, and a control circuit, the blood pressure measuring method comprising the following steps of:

during an initial operation, the air pump inflating a blood pressure cuff to a preset pressure value at an initial pressurization rate, and the control circuit obtaining an initial pressurization time length;

the control circuit determining whether to adjust a pressure relief time length of the blood pressure cuff according to the initial pressurization time length; and

when the control circuit determining that the pressure relief time length needs to be adjusted, during the measurement operation, while the air release valve with constant speed is releasing air from the blood pressure cuff, the control circuit controlling the air pump to inflate the blood pressure cuff to adjust the pressure relief time length.

10. The blood pressure measuring method of claim 9, further comprising the following steps of:

when the initial pressurization time length is less than or greater than a reference value of the pressurization time length, the control circuit determining whether to adjust at least one of the initial pressurization time length and the pressure relief time length.

11. The blood pressure measuring method of claim 9, wherein when the initial pressurization rate corresponds to an initial pressurization current, the pressurization rate corresponds to a pressurization current, and the pressurization current is 40% to 80% of the initial pressurization current.

12. The blood pressure measuring method of claim 9, further comprising the following steps of:

when the pressure relief time length needs to be adjusted, the control circuit inputting an adjustment current to the air pump, so as to cause the air pump to inflate the blood pressure cuff according to the adjustment current, while the air release valve with constant speed is deflating the blood pressure cuff; wherein, the initial pressurization time length corresponds to an initial pressurization current, and the adjustment current is 3% to 20% of the initial pressurization current.

13. The blood pressure measuring method of claim 9, further comprising the following steps of:

the control circuit adjusting a pressurization current input to the air pump to adjust the pressurization time length, so that the pressurization time length is not

less than the reference value of the pressurization time length.

14. The blood pressure measuring method of claim 13, wherein the adjusted pressure relief time length is at least three times the adjusted pressurization time length.

15. The blood pressure measuring method of claim 9, further comprising the following steps of:

during the measurement operation, the air pump inflating the blood pressure cuff to a measurement pressure value at a pressurization rate, and the control circuit obtaining a pressurization time length;

wherein, the measurement pressure value is either the same as the preset pressure value or the difference between the measurement pressure value and the preset pressure value is within a difference threshold;

wherein, the measurement pressure value is adjusted according to a blood pressure measurement mode of the blood pressure measuring device.

16. The blood pressure measuring method of claim 9, further comprising the following steps of:

the control circuit adjusting or adding a blood pressure measurement mode of the blood pressure measuring device according to the initial pressurization time length is less than or greater than a reference value of the pressurization time length.