US 20200107812A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2020/0107812 A1

(43) Pub. Date: Apr. 9, 2020

Wang et al.

(54) **ULTRASONIC-BASED PULSE-TAKING DEVICE AND PULSE-TAKING METHOD**

(71) Applicant: **Acer Incorporated**, New Taipei City (TW)

(72) Inventors: **Jyun-Guo Wang**, New Taipei City (TW); **Yin-Hsong Hsu**, New Taipei City (TW)

(73) Assignee: **Acer Incorporated**, New Taipei City (TW)

(21) Appl. No.: **16/209,989**

(22) Filed: **Dec. 5, 2018**

(30) **Foreign Application Priority Data**

Oct. 4, 2018 (TW) 107135144

Publication Classification

(51) **Int. Cl.**

A61B 8/08 (2006.01)

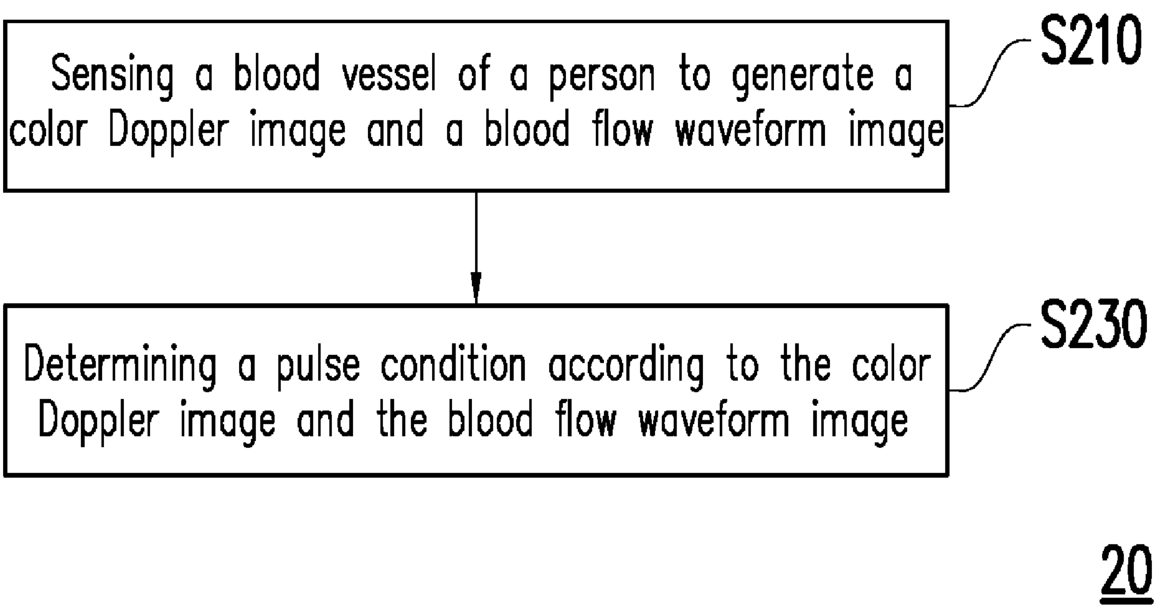
A61B 8/06 (2006.01)

(52) **U.S. Cl.**

CPC .. ***A61B 8/0891*** (2013.01); *G06T 2207/10132* (2013.01); ***A61B 8/488*** (2013.01); ***A61B 8/06*** (2013.01)

(57) **ABSTRACT**

An ultrasonic-based pulse-taking device and a pulse-taking method thereof which are adapted to detect a pulse condition of a person are provided. The pulse-taking method includes: sensing a blood vessel of the person to generate a color Doppler image and a blood flow waveform image. Determining the pulse condition based on the color Doppler image and the blood flow waveform image.



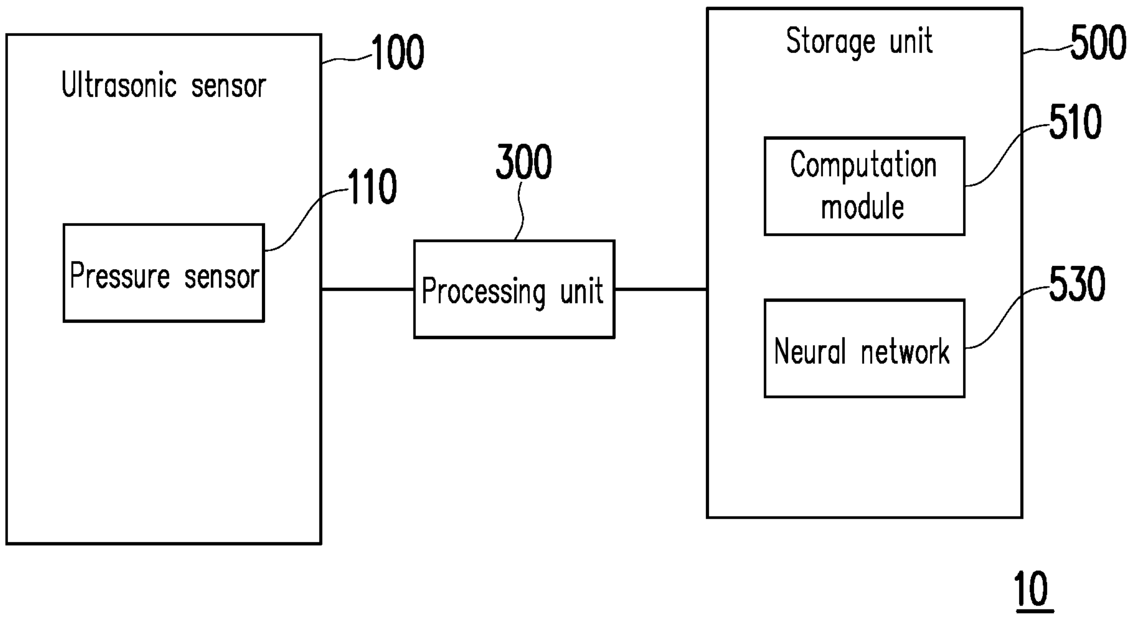

Ultrasonic sensor
100
Pressure sensor
110
300
Processing unit
Storage unit
500
Computation module
510
Neural network
530
10

FIG. 1

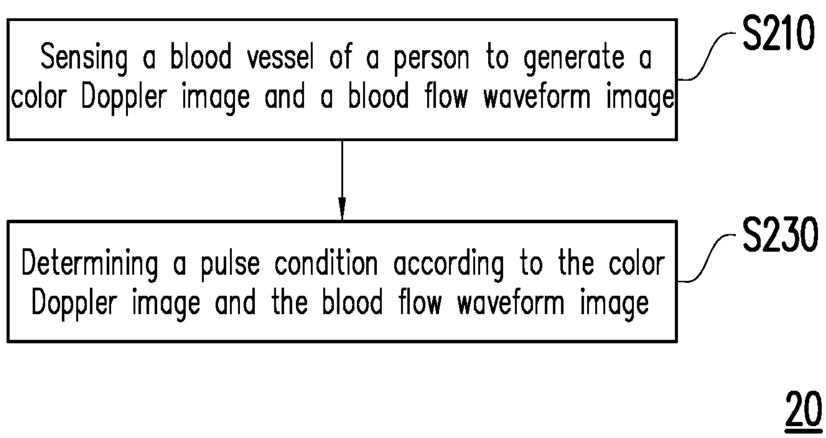

Sensing a blood vessel of a person to generate a color Doppler image and a blood flow waveform image
S210
Determining a pulse condition according to the color Doppler image and the blood flow waveform image
S230
20

FIG. 2

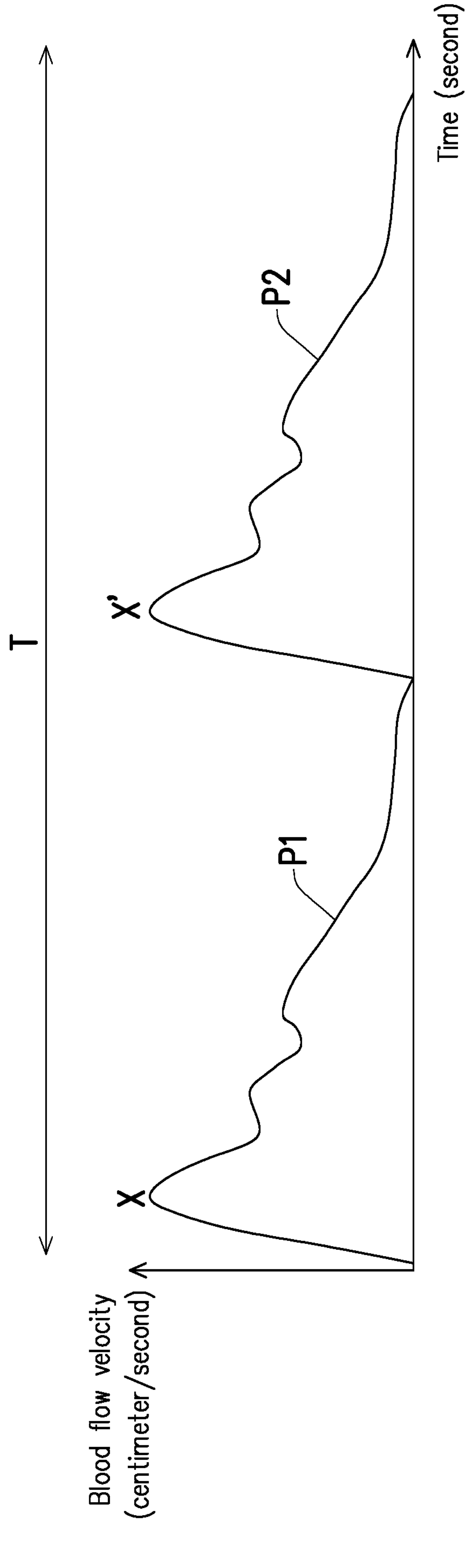

T
X
X'
P1
P2
Time (second)
Blood flow velocity
(centimeter/second)

FIG. 3

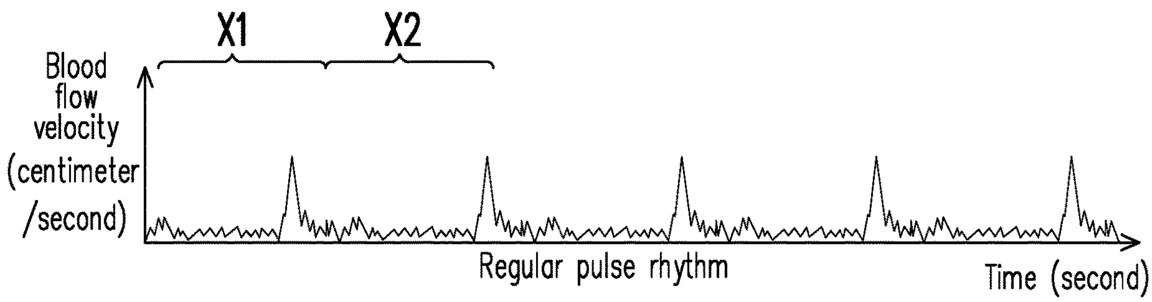

X1
X2
Blood flow velocity (centimeter /second)
Regular pulse rhythm
Time (second)

FIG. 4A

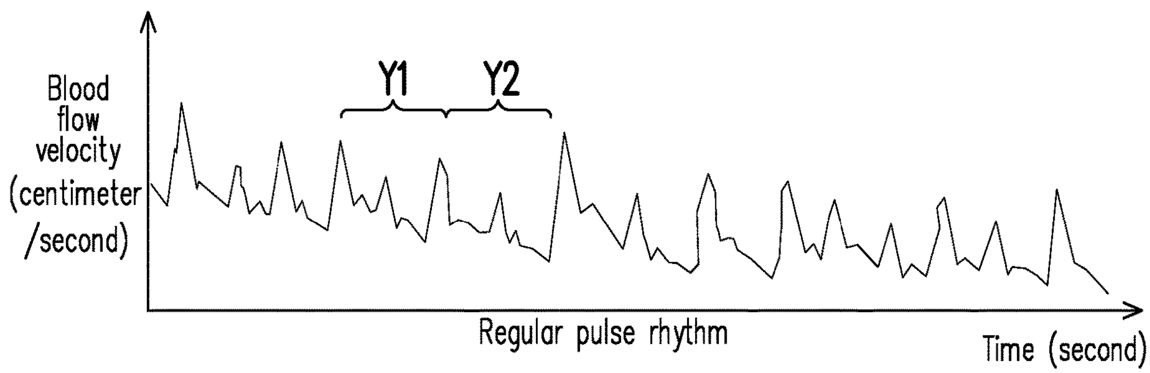

Y1
Y2
Blood flow velocity (centimeter /second)
Regular pulse rhythm
Time (second)

FIG. 4B

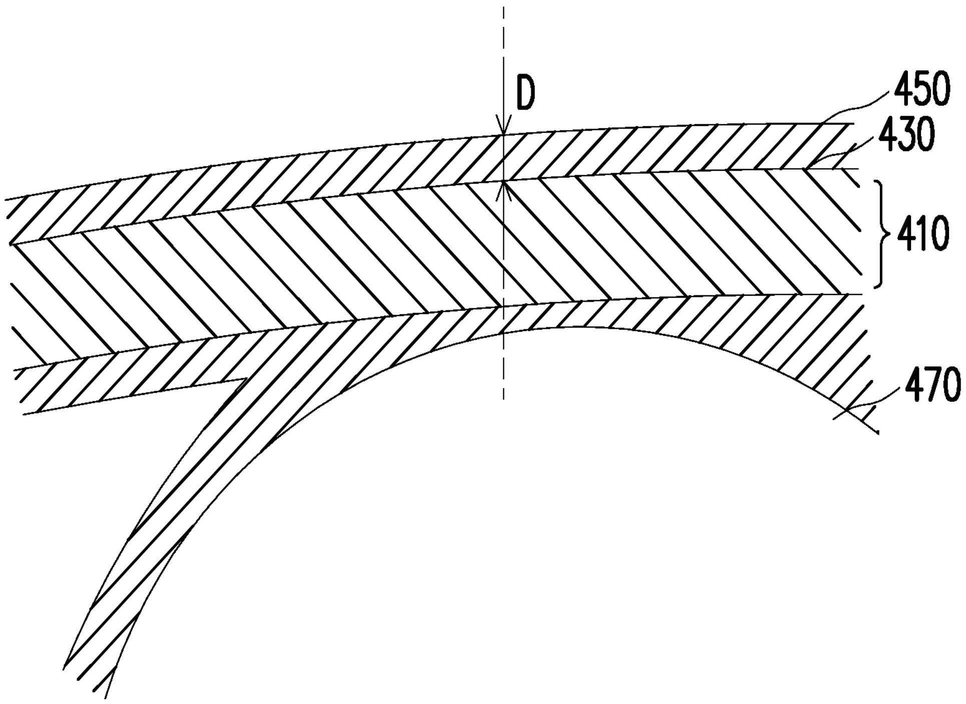


FIG. 5

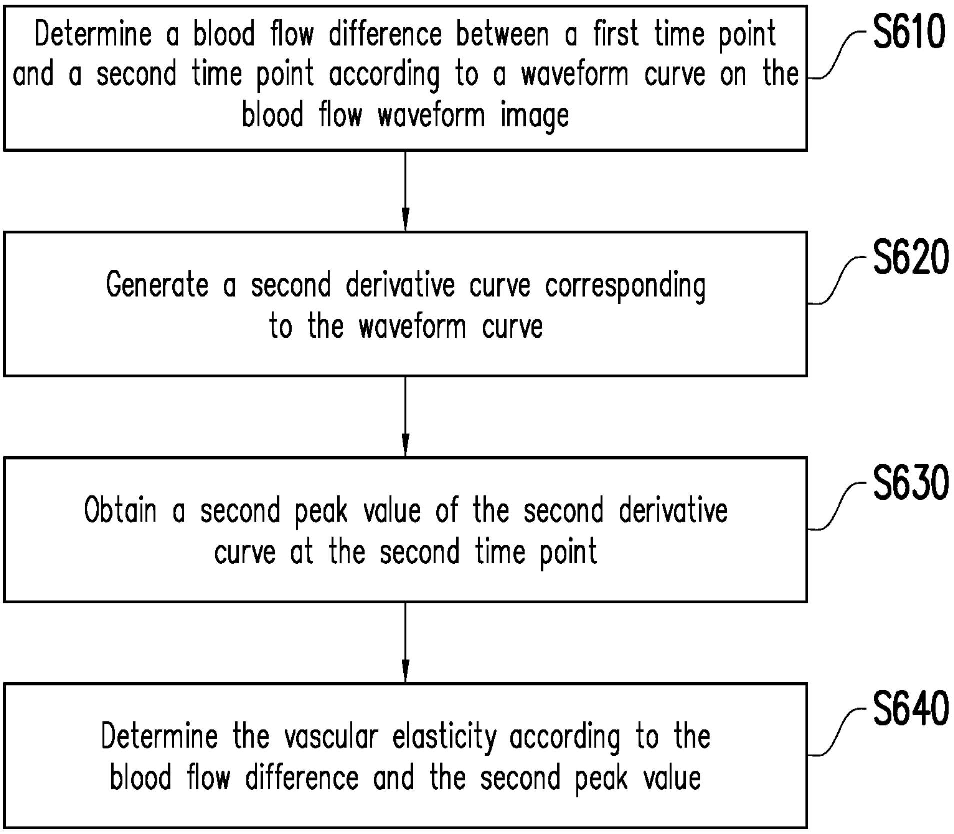

Determine a blood flow difference between a first time point and a second time point according to a waveform curve on the blood flow waveform image
S610
Generate a second derivative curve corresponding to the waveform curve
S620
Obtain a second peak value of the second derivative curve at the second time point
S630
Determine the vascular elasticity according to the blood flow difference and the second peak value
S640

FIG. 6A

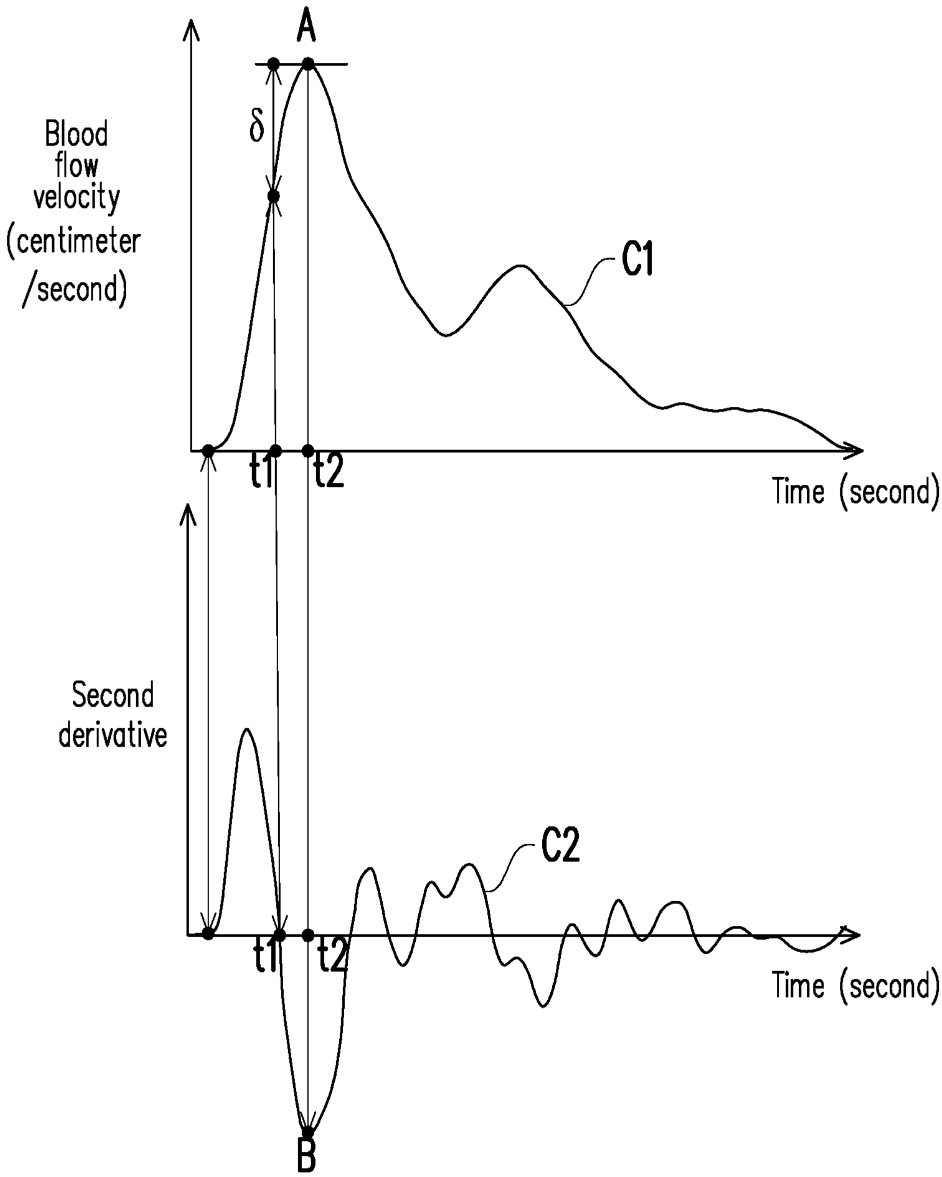

A
δ
Blood
flow
velocity
(centimeter
/second)
C1
t1
t2
Time (second)
Second
derivative
C2
t1
t2
Time (second)
B

FIG. 6B

ULTRASONIC-BASED PULSE-TAKING DEVICE AND PULSE-TAKING METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefit of Taiwan application serial no. 107135144, filed on Oct. 4, 2018. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The invention relates to a pulse-taking technique, and particularly relates to an ultrasonic-based pulse-taking device and a pulse-taking method.

Description of Related Art

[0003] When a Traditional Chinese Medicine (TCM) physician interviews a patient, the TCM physician obtains information of the patient through four ways of diagnosis including "observation, auscultation and olfaction, inquiry and pulse-feeling", where "pulse-feeling" is pulse-taking. When pulse-taking is performed, the TCM physician generally feels a pulse condition (i.e. a state of the pulse) of the patient by palpation. However, since the pulse condition obtained through the palpation cannot be converted into quantifiable information, the TCM physician can only judge the pulse condition by his own experience. Such pulse diagnosis method is often easy to cause people's doubt.

[0004] In recent years, many researchers have designed various types of pulse-taking devices, though these pulse-taking devices cannot measure enough information to determine all types of pulse conditions. Therefore, these pulse-taking devices are still in the stage of clinical trials and cannot be widely used.

SUMMARY OF THE INVENTION

[0005] In order to obtain enough information to accurately determine various types of pulse conditions, the invention is directed to an ultrasonic-based pulse-taking device and a pulse-taking method.

[0006] The invention provides an ultrasonic-based pulse-taking device, which is adapted to determine a pulse condition of a person. The pulse-taking device includes a storage unit, an ultrasonic sensor and a processing unit. The storage unit stores a plurality of modules. The ultrasonic sensor senses a blood vessel of the person to generate a color Doppler image and a blood flow waveform image. The processing unit is coupled to the storage unit and the ultrasonic sensor, and accesses and executes the modules stored in the storage unit. The modules stored in the storage unit include a computation module. The computation module determines the pulse condition according to the color Doppler image and the blood flow waveform image.

[0007] The invention provides an ultrasonic-based pulse-taking method, which is adapted to determine a pulse condition of a person. The pulse-taking method includes: sensing a blood vessel of the person to generate a color Doppler image and a blood flow waveform image; and determining the pulse condition according to the color Doppler image and the blood flow waveform image.

[0008] Based on the above description, the invention adopts the ultrasonic technique to determine related information of the pulse condition, so as to provide scientific pulse-taking information.

[0009] In order to make the aforementioned and other features and advantages of the invention comprehensible, several exemplary embodiments accompanied with figures are described in detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

[0011] FIG. **1** is a schematic diagram of an ultrasonic-based pulse-taking device according to an embodiment of the invention.

[0012] FIG. **2** is a flowchart illustrating an ultrasonic-based pulse-taking method according to an embodiment of the invention.

[0013] FIG. **3** is a schematic diagram of a blood flow waveform image according to an embodiment of the invention.

[0014] FIGS. **4**A and **4**B are schematic diagrams of blood flow waveform images according to another embodiment of the invention.

[0015] FIG. **5** is a schematic diagram of a color Doppler image according to an embodiment of the invention.

[0016] FIG. **6**A is a flowchart illustrating a method for determining vascular elasticity according to an embodiment of the invention.

[0017] FIG. **6**B is a schematic diagram of a waveform curve of the blood waveform diagram of a radial artery and a second derivative curve corresponding to the waveform curve according to an embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

[0018] In order to provide quantifiable pulse-taking information, the invention provides an ultrasonic-based pulse-taking device and a pulse-taking method. The spirit of the invention is conveyed with reference of following content.

[0019] FIG. **1** is a schematic diagram of an ultrasonic-based pulse-taking device **10** according to an embodiment of the invention. The pulse-taking device **10** is adapted to determine a pulse condition of a person. Generally, the pulse condition is determined according to a pulse of a radial artery of the person, though the pulse-taking device **10** of the invention may also be adapted to the pulse condition of any type of blood vessels. The pulse-taking device **10** may include an ultrasonic sensor **100**, a processor **300** and a storage unit **500**.

[0020] The ultrasonic sensor **100** is, for example, a medical ultrasonic sensor, or any sensor adapted to generate a color Doppler image and a blood flow waveform image through the ultrasonic technique. In order to control a pressure applied to a tested part of human body when the ultrasonic sensor **100** contacts the tested part of human body, in some embodiments, the ultrasonic sensor **100** may further include a pressure sensor **110** used for measuring the pressure applied to the tested part by the ultrasonic sensor **100**.

[0021] The processing unit **300** is coupled to the ultrasonic sensor **100** and the storage unit **500**, and is adapted to access and execute a plurality of modules stored in the storage unit **500**. The processing unit **300** is, for example, a Central Processing Unit (CPU), or other programmable general purpose or special purpose microprocessor, a Digital Signal Processor (DSP), a programmable controller, an Application Specific Integrated Circuit (ASIC) or other similar device or a combination of the above devices.

[0022] The storage unit **500** is used for storing various software, data and various program codes required for operation of the pulse-taking device **10**. The storage unit **500** is, for example, any type of a fixed or movable Random Access Memory (RAM), a Read-only Memory (ROM), a flash memory, a Hard Disk Drive (HDD), a Solid State Drive (SSD) or a similar device or a combination of the above devices.

[0023] In the embodiment, the storage unit **500** may store a computation module **510**. In some embodiments, the storage unit **500** may further store a neural network **530**. Functions of the computation module **510** and the neural network **530** are described later.

[0024] FIG. **2** is a flowchart illustrating an ultrasonic-based pulse-taking method **20** according to an embodiment of the invention. The pulse-taking method **20** is adapted to determine a pulse condition of a person, and is adapted to be implemented by the pulse-taking device **10** of FIG. **1**.

[0025] In step S**210**, the pulse-taking device **10** senses a blood vessel of the person to generate a color Doppler image and a blood flow waveform image.

[0026] In step S**230**, the computation module **510** determines a pulse condition according to the color Doppler image and the blood flow waveform image. The pulse condition may include a vascular position and depth, a pulse rate, a pulse strength, a pulse rhythm or a vascular elasticity, though the invention is not limited thereto. To be specific, the blood flow waveform image may be used for determining the pulse conditions such as the vascular position and depth, the pulse rate, the pulse strength or the pulse rhythm, etc., and the color Doppler image may be used for determining pulse conditions such as the vascular position and depth or the vascular elasticity, etc., though the invention is not limited thereto.

[0027] FIG. **3** is a schematic diagram of the blood flow waveform image according to an embodiment of the invention. The blood flow waveform image of FIG. **3** illustrates waveform curves of two pulses, which are respectively a waveform curve P**1** and a waveform curve P**2** representing a blood flow velocity. The computation module **510** may determine the pulse rate according to the number of the waveform curves generated within a measuring time (the number of the waveform curves/the measuring time). For example, if two waveform curves (i.e. the waveform curve P**1** and the waveform curve P**2**) are generated within a measuring time T, the computation module **510** may determine the pulse rate as 2/T (unit: times/second), which may be converted into a commonly used unit of the pulse rate as 2/T*60 (unit: times/minute). The number of the waveform curves may be obtained based on the number of times that peak values (for example, X and X' of FIG. **3**) appear, which is not limited by the invention. In some embodiments, the pulse-taking device **10** may train the neural network **530** according to historical data, such that the computation module **510** may determine the pulse rate according to the blood flow waveform image and the neural network **530**.

[0028] Moreover, the blood flow waveform image of FIG. **3** may also be used for determining the pulse strength. The computation module **510** may determine the pulse strength according to the peak values of the waveform curves in the blood flow waveform image. For example, the computation module **510** may obtain the peak value X (unit: centimeter/second) of the waveform curve P**1** through the ultrasonic sensor **100**, and convert the peak value X (unit: centimeter/second) into the corresponding pulse strength. In some embodiments, the pulse-taking device **10** may train the neural network **530** according to historical data, such that the computation module **510** may determine the pulse strength according to the blood flow waveform image and the neural network **530**.

[0029] Moreover, the blood flow waveform image of FIG. **3** may also be used for determining a vascular position (for example, Chon, Gwan and Check in the TCM domain) and depth (floating, moderate, sinking in the TCM domain). Generally, the pulse strengths measure at Chon, Gwan and Ckeck are stronger. Therefore, the computation module **510** may determine whether the vascular position sensed by the ultrasonic sensor **100** is at Chon, Gwan and Ckeck according to the peak values of the waveform curves in the blood flow waveform image. On the other hand, the vascular depth may also influence the peak values of the waveform curves. Generally, the deeper the vascular position is, the weaker the measured pulse strength is. Conversely, the shallower the vascular position is, the stronger the measured pulse strength is. Therefore, the computation module **510** may determine whether the vascular depth sensed by the ultrasonic sensor **100** is in a floating, moderate or sinking state according to the peak values of the waveform curves in the blood flow waveform image. In some embodiments, pulse-taking device **10** may train the neural network **530** according to historical data, such that the computation module **510** may determine the pulse rhythm and the vascular position and depth according to the blood flow waveform image and the neural network **530**.

[0030] FIGS. **4**A and **4**B are schematic diagrams of blood flow waveform images according to another embodiment of the invention. FIGS. **4**A and **4**B respectively illustrate blood flow waveform images when the pulse rhythm is regular and when the pulse rhythm is irregular. The computation module **510** may determine the pulse rhythm according to a waveform of the pulse. For example, a waveform curve X**1** and a waveform curve X**2** respectively representing two pulses in FIG. **4**A have similar waveforms (for example, periods and blood flow velocities of the waveform curve X**1** and the waveform curve X**2** are similar). Therefore, the computation module **510** may determine that the pulse rhythm is regular based on the fact that the measured pulse waveform curves are similar. On the other hand, a waveform curve Y**1** and a waveform curve Y**2** respectively representing two pulses in FIG. **4**B have different waveforms (for example, periods and blood flow velocities of the waveform curve Y**1** and the waveform curve Y**2** are quite different). Therefore, the computation module **510** may determine that the pulse rhythm is irregular based on the fact that the measured pulse waveform curves are different. In some embodiments, the pulse-taking device **10** may train the neural network **530** according to historical data, such that the computation module **510** may determine the pulse rhythm according to the blood flow waveform image and the neural network **530**.

[0031] FIG. **5** is a schematic diagram of a color Doppler image according to an embodiment of the invention. The color Doppler image of FIG. **5** illustrates different parts including a radial artery **410**, a vascular wall **430**, skin epidermis **450** and a radius **470**, etc. Based on different blood flow directions, the radial artery **410** in the color Doppler image may present a red color or a blue color. The computation module **510** may determine the vascular position and depth according to a distance between the skin epidermis and the vessel. For example, the computation module **510** may determine the vascular position and depth according to a distance D between the skin epidermis **450** and the vascular wall **430**. In some embodiments, the pulse-taking device **10** may train the neural network **530** according to historical data, such that the computation module **510** may determine the vascular position and depth according to the color Doppler image and the neural network **530**.

[0032] FIG. **6**A is a flowchart illustrating a method for determining vascular elasticity according to an embodiment of the invention. FIG. **6**B is a schematic diagram of a waveform curve C**1** of the blood waveform diagram of the radial artery and a second derivative curve C**2** corresponding to the waveform curve C**1** according to an embodiment of the invention. FIG. **6**A and FIG. **6**B may assist understanding the flow of determining the vascular elasticity.

[0033] In step S**610**, the computation module **510** determines a blood flow difference δ between a first time point t**1** and a second time point t**2** according to the waveform curve C**1** on the blood flow waveform image, where the second time point t**2** is a time point that the waveform curve C**1** reaches a first peak value A. In step S**620**, the computation module **510** generates the second derivative curve C**2** corresponding to the waveform curve C**1**. In step S**630**, the computation module **510** obtains a second peak value B of the second derivative curve C**2** at the second time point t**2**. In step S**640**, the computation module **510** determines the vascular elasticity according to the blood flow difference δ and the second peak value B. To be specific, the computation module **510** may determine a coefficient K of the vascular elasticity during a period between the first time point T**1** and the second time point t**2** according to a following equation (1), where B is the peak value of the second derivative curve C**2** of the waveform curve C**1** on the blood flow waveform image at the second time point t**2**, and δ is the blood flow difference on the waveform curve C**1** of the blood flow waveform image between the first time point t**2** and the second time point t**2**.

$$K=B/\delta \qquad \text{equation (1)}$$

[0034] A following table 1 records meanings of the coefficient K of the vascular elasticity calculated according to the equation (1).

TABLE 1

Coefficient K of vascular elasticity	Abnormality degree of vascular elasticity
>1.978	Just as well
1.672~1.978	Normal
1.511~1.672	Slight abnormal

TABLE 1-continued

Coefficient K of vascular elasticity	Abnormality degree of vascular elasticity
1.047~1.511	Moderate abnormal
<1.047	Severe abnormal

[0035] In summary, the invention adopts the ultrasonic technique to determine related information of the pulse condition. Based on the color Doppler image and the blood flow waveform image generated by the ultrasonic sensor, many pulse conditions including the vascular position and depth, the pulse rate, the pulse strength, the pulse rhythm and the vascular elasticity of the user may be accurately determined. In this way, information of the pulse conditions may be scientifically quantified, so as to improve people's trust in pulse diagnosis.

[0036] It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. An ultrasonic-based pulse-taking device, adapted to determine a pulse condition of a person, and comprising:

a storage unit, storing a plurality of modules;

an ultrasonic sensor, sensing a blood vessel of the person to generate a color Doppler image and a blood flow waveform image; and

a processing unit, coupled to the storage unit and the ultrasonic sensor, and accessing and executing the modules stored in the storage unit, wherein the modules comprise:

a computation module, determining the pulse condition according to the color Doppler image and the blood flow waveform image.

2. The ultrasonic-based pulse-taking device as claimed in claim **1**, wherein the pulse condition comprises at least one of a vascular position and depth, a pulse rate, a pulse strength, a pulse rhythm and a vascular elasticity.

3. The ultrasonic-based pulse-taking device as claimed in claim **2**, wherein the step of determining the pulse condition according to the color Doppler image and the blood flow waveform image comprises:

determining at least one of the vascular position and depth and the vascular elasticity according to the color Doppler image.

4. The ultrasonic-based pulse-taking device as claimed in claim **2**, wherein the step of determining the pulse condition according to the color Doppler image and the blood flow waveform image comprises:

determining at least one of the vascular position and depth, the pulse rate, the pulse strength, and the pulse rhythm according to the blood flow waveform image.

5. The ultrasonic-based pulse-taking device as claimed in claim **2**, wherein the computation module determines the vascular elasticity according to following steps:

determining a blood flow difference between a first time point and a second time point according to a waveform curve on the blood flow waveform image, wherein the second time points is a time point when the waveform curve reaches a first peak value;

generating a second derivative curve corresponding to the waveform curve;
obtaining a second peak value of the second derivative curve at the second time point; and
determining the vascular elasticity according to the blood flow difference and the second peak value.

6. The ultrasonic-based pulse-taking device as claimed in claim **2**, wherein the computation module determines the vascular position and depth according to a distance between skin epidermis and the blood vessel.

7. The ultrasonic-based pulse-taking device as claimed in claim **2**, wherein the modules further comprise:
a neural network, wherein the computation module determines the pulse condition according to the neural network, the blood flow waveform image, and the color Doppler image.

8. An ultrasonic-based pulse-taking method, adapted to determine a pulse condition of a person, and comprising:
sensing a blood vessel of the person to generate a color Doppler image and a blood flow waveform image; and
determining the pulse condition according to the color Doppler image and the blood flow waveform image.

9. The ultrasonic-based pulse-taking method as claimed in claim **8**, wherein the pulse condition comprises at least one of a vascular position and depth, a pulse rate, a pulse strength, a pulse rhythm and a vascular elasticity.

10. The ultrasonic-based pulse-taking method as claimed in claim **9**, wherein the step of determining the pulse condition according to the color Doppler image and the blood flow waveform image comprises:
determining at least one of the vascular position and depth and the vascular elasticity according to the color Doppler image.

11. The ultrasonic-based pulse-taking method as claimed in claim **9**, wherein the step of determining the pulse condition according to the color Doppler image and the blood flow waveform image comprises:
determining at least one of the vascular position and depth, the pulse rate, the pulse strength and the pulse rhythm according to the blood flow waveform image.

12. The ultrasonic-based pulse-taking method as claimed in claim **9**, wherein the step of determining the pulse condition according to the color Doppler image and the blood flow waveform image comprises:
determining a blood flow difference between a first time point and a second time point according to a waveform curve on the blood flow waveform image, wherein the second time points is a time point when the waveform curve reaches a first peak value;
generating a second derivative curve corresponding to the waveform curve;
obtaining a second peak value of the second derivative curve at the second time point; and
determining the vascular elasticity according to the blood flow difference and the second peak value.

13. The ultrasonic-based pulse-taking method as claimed in claim **9**, wherein the step of determining the pulse condition according to the color Doppler image and the blood flow waveform image comprises:
determining the vascular position and depth according to a distance between skin epidermis and the blood vessel.

14. The ultrasonic-based pulse-taking method as claimed in claim **9**, wherein the step of determining the pulse condition according to the color Doppler image and the blood flow waveform image comprises:
determining the pulse condition according to a neural network, the blood flow waveform image and the color Doppler image.

* * * * *

专利名称(译)	超声波脉冲采集装置及脉冲采集方法		
公开(公告)号	US20200107812A1	公开(公告)日	2020-04-09
申请号	US16/209989	申请日	2018-12-05
[标]申请(专利权)人(译)	宏碁股份有限公司		
申请(专利权)人(译)	宏碁股份有限公司		
当前申请(专利权)人(译)	宏碁股份有限公司		
[标]发明人	HSU YIN HSONG		
发明人	WANG, JYUN-GUO HSU, YIN-HSONG		
IPC分类号	A61B8/08 A61B8/06		
CPC分类号	A61B8/488 G06T2207/10132 A61B8/0891 A61B8/06 A61B8/485		
优先权	107135144 2018-10-04 TW		
外部链接	Espacenet USPTO		

摘要(译)

提供了一种适于检测人的脉搏状况的基于超声波的脉搏采集装置及其脉搏采集方法。 脉搏采集方法包括：感测人的血管以产生彩色多普勒图像和血流波形图像。 根据彩色多普勒图像和血流波形图像确定脉搏状态。