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Wu et al.

(54) POWER MANAGEMENT METHOD AND ULTRASOUND APPARATUS THEREOF

(71) Applicant: **Leltek Inc.**, New Taipei City (TW)

(72) Inventors: **Chien-Hsin Wu**, New Taipei City (TW); **Ying-Yi Liu**, Taipei City (TW); **Sheng-Chang Peng**, Taipei City (TW); **Kuo-Ping Liu**, Taipei City (TW)

(73) Assignee: **Leltek Inc.**, New Taipei City (TW)

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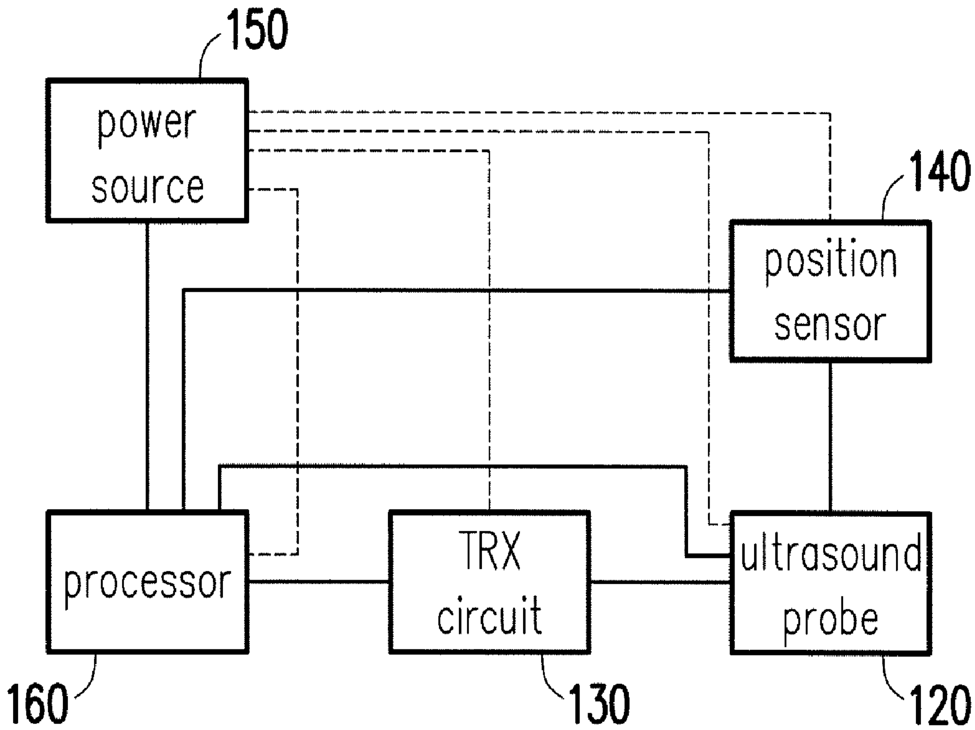
(57) **ABSTRACT**

The disclosure is directed to a power management method and an ultrasound apparatus using the same. The ultrasound apparatus includes an ultrasound probe, an TRX circuit, a position sensor, and a processor. In the disclosure, power is supplied to the ultrasound apparatus, and an ultrasound scanning is performed. During the ultrasound scanning, position information of the ultrasound probe is being continuously detected by the position sensor. Whether the ultrasound probe is in a static state during the ultrasound scanning is determined. When determined that the ultrasound probe is in the static state during the ultrasound scanning, a power saving mode is entered, such that the ultrasound scanning is stopped. Within the power saving mode, the position information is continuously detected. Whether the ultrasound probe is still in the static state under the power saving mode is determined. When determined that the ultrasound probe is still in the static state under the power saving mode, no power is being supplied to the TRX circuit.



100

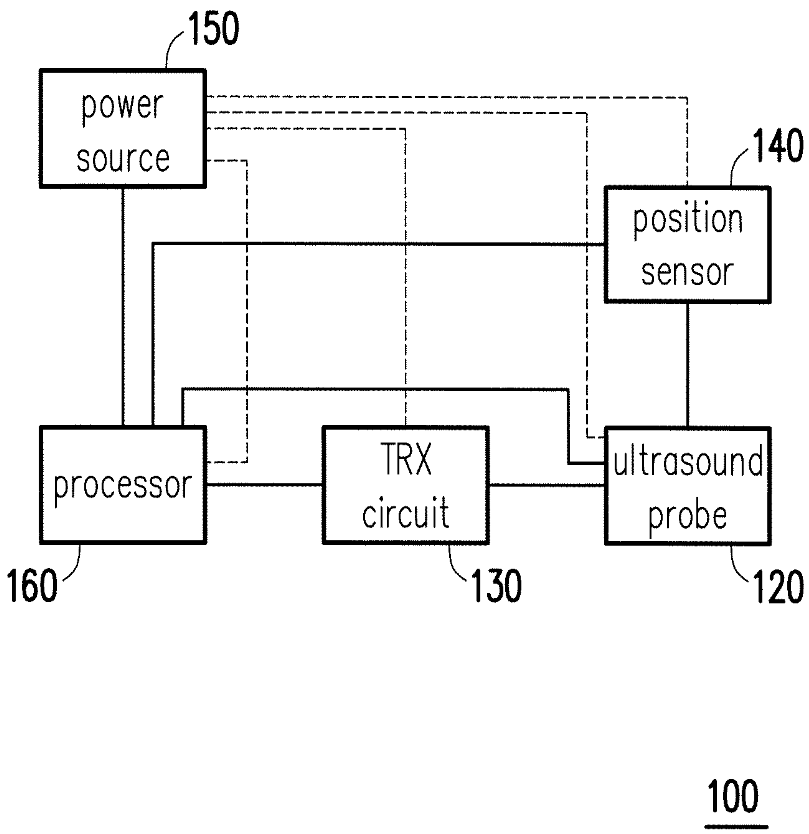

150
power source
140
position sensor
processor
TRX circuit
ultrasound probe
160
130
120
100

FIG. 1

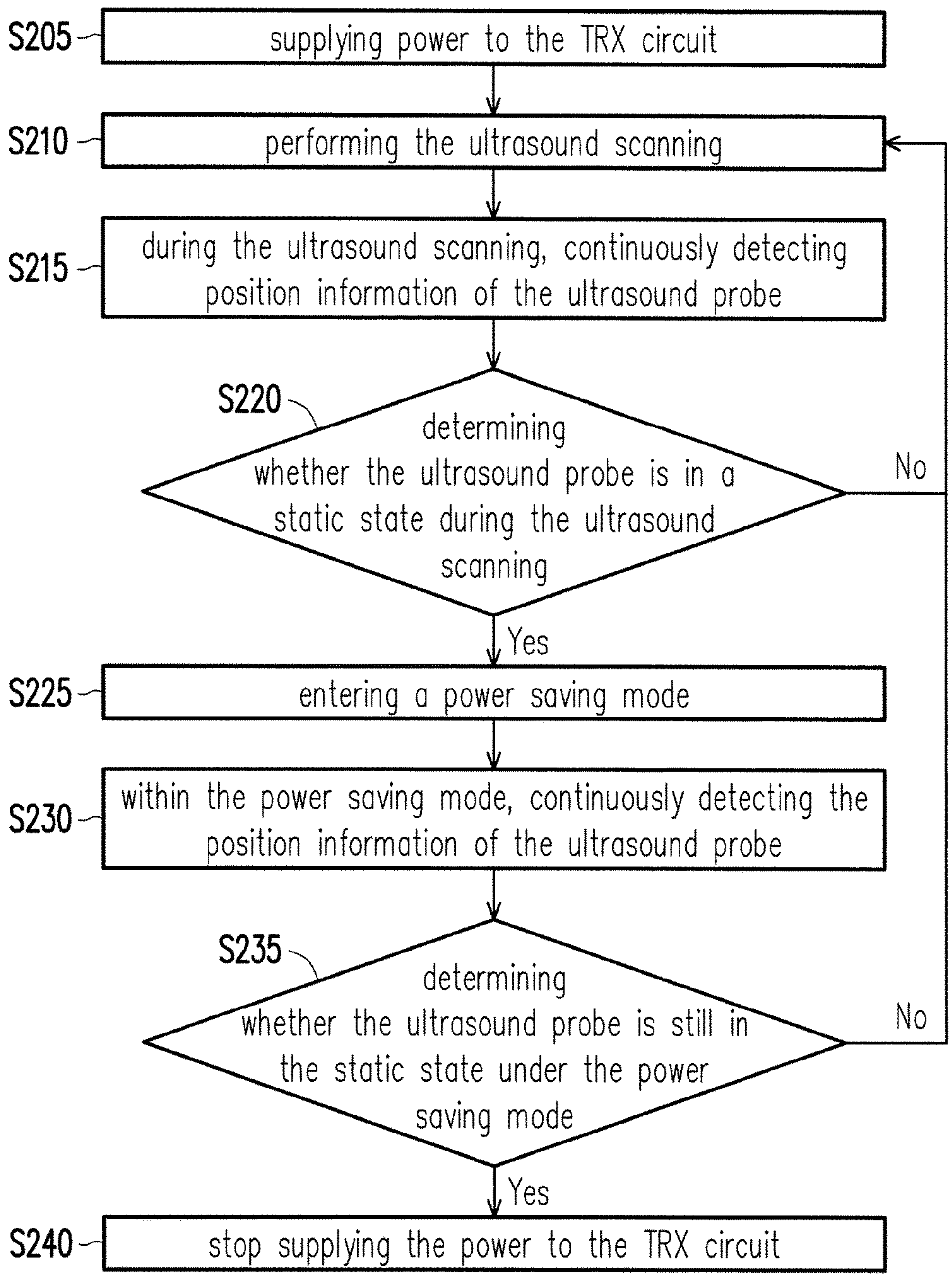

S205
supplying power to the TRX circuit
S210
performing the ultrasound scanning
S215
during the ultrasound scanning, continuously detecting position information of the ultrasound probe
S220
determining whether the ultrasound probe is in a static state during the ultrasound scanning
No
Yes
S225
entering a power saving mode
S230
within the power saving mode, continuously detecting the position information of the ultrasound probe
S235
determining whether the ultrasound probe is still in the static state under the power saving mode
No
Yes
S240
stop supplying the power to the TRX circuit

FIG. 2

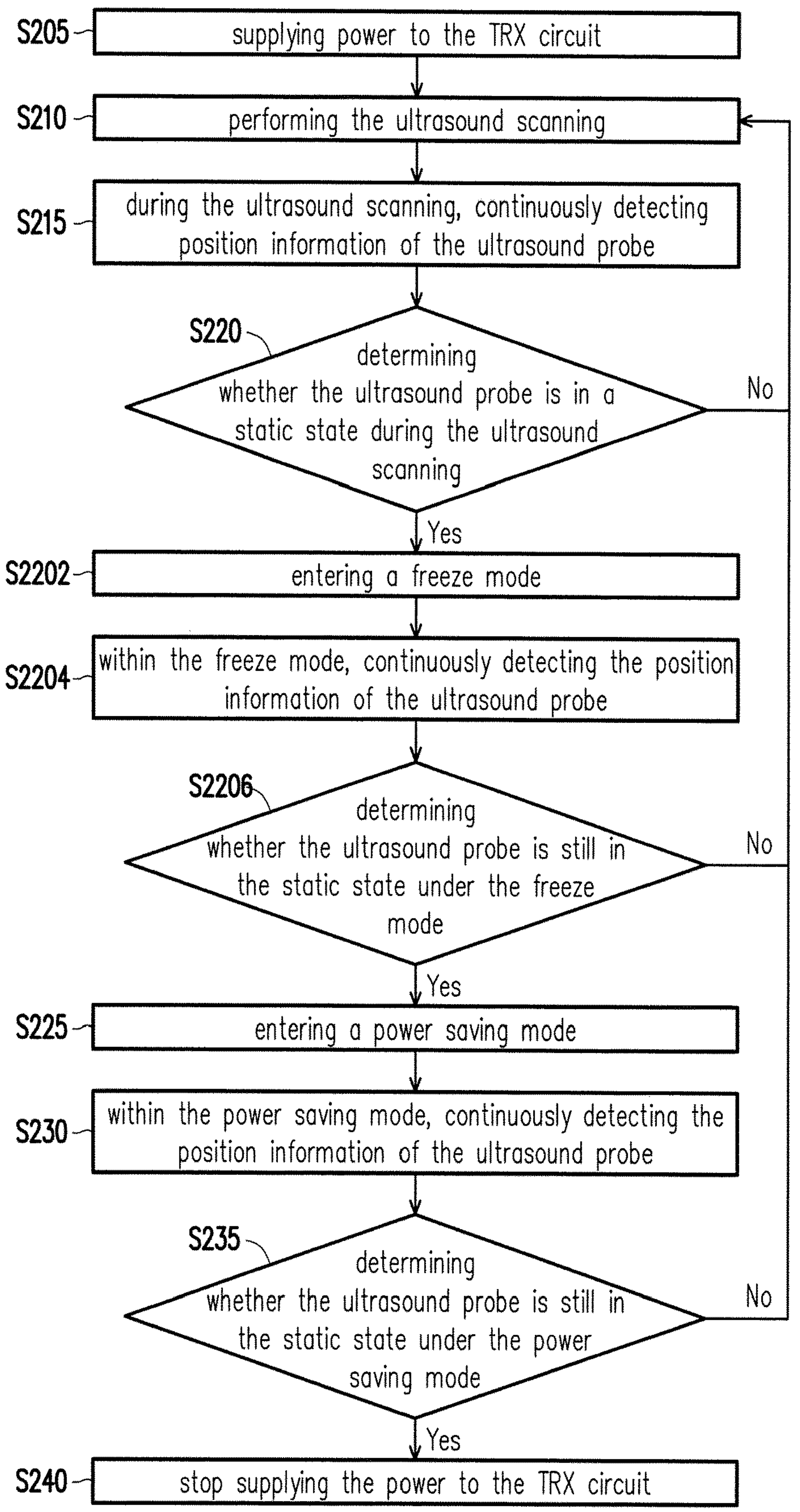

S205
supplying power to the TRX circuit
S210
performing the ultrasound scanning
S215
during the ultrasound scanning, continuously detecting position information of the ultrasound probe
S220
determining whether the ultrasound probe is in a static state during the ultrasound scanning
No
Yes
S2202
entering a freeze mode
S2204
within the freeze mode, continuously detecting the position information of the ultrasound probe
S2206
determining whether the ultrasound probe is still in the static state under the freeze mode
No
Yes
S225
entering a power saving mode
S230
within the power saving mode, continuously detecting the position information of the ultrasound probe
S235
determining whether the ultrasound probe is still in the static state under the power saving mode
No
Yes
S240
stop supplying the power to the TRX circuit

FIG. 3

POWER MANAGEMENT METHOD AND ULTRASOUND APPARATUS THEREOF

BACKGROUND

Technical Field

[0001] The disclosure relates to a power management method and an ultrasound apparatus thereof, where the power management method is adapted to the ultrasound apparatus.

Description of Related Art

[0002] Ultrasound has been widely used in medical diagnosis, military radar system and rusting detection. In the medical diagnosis system, the ultrasound is often used in imaging internal body structures such as tendons, muscles, joints, vessels and internal organs. Since the image obtained by the ultrasound may clearly show the internal body, illness or disease may be correctly examined, and appropriate treatment could be chosen and performed by medical personnel, so as to effectively cure a patient.

[0003] Most conventional ultrasound devices are manually activated and deactivated. That is to say, those ultrasound devices will not be shut down automatically. However, for maintaining the operation of the ultrasound device, power consumption is considerable, which usually leads to the result that the portable type ultrasound device can only be used for a short time. Further, heat generated from the continually operated ultrasound device also cause the examinee feeling uncomfortable. Therefore, it is expected that the ultrasound device may be temporarily shut down or turned into a low power consumption mode under automatic control. In other words, it is still a goal of effort for those technicians of the field to provide an efficient and accurate power management mechanism for ultrasound devices.

SUMMARY

[0004] The disclosure is directed to a power management method and an ultrasound apparatus thereof, by which power of the ultrasound apparatus is efficiently and accurately managed.

[0005] An embodiment of the disclosure provides a power management method, adapted to an ultrasound apparatus including an ultrasound probe, a TRX (transmit/receive) circuit (which includes an analog-front-end (AFE) circuit and a pulser), a position sensor, a power source and a processor (such as FPGA, MCU, . . . etc.) The power management method includes following steps. Power is supplied to the TRX circuit and the processor. An ultrasound scanning is performed by the TRX circuit, the processor is capturing and calculating ultrasound images. During the ultrasound scanning, position information of the ultrasound apparatus is continuously detected. According to the detected position information, when determined that the ultrasound probe is in a static state during the ultrasound scanning, the ultrasound apparatus enters a power saving mode. In the power saving mode, the ultrasound scanning is stopped and the processor is suspended. Under the power saving mode, the position information of the ultrasound probe is periodically checked by the processor. When determined that the ultrasound probe is still in the static state under the power saving mode, according to the detected position information, the processor controls the power supply to stop supply power to the TRX circuit.

[0006] In an embodiment of the present disclosure, the ultrasound probe is determined as in the static state when the movement of the ultrasound probe, recognized from the detected position information, falls in a predefined range in a period.

[0007] In an embodiment of the present disclosure, when determined that the ultrasound probe is not in the static state during the ultrasound scanning, the ultrasound scanning continuously proceeds, and the position information of the ultrasound probe is continuously detected.

[0008] In an embodiment of the present disclosure, when determined that the ultrasound probe is in the static state during the ultrasound scanning, the power management method goes through following steps before entering the power saving mode. A freeze mode is entered to stop the ultrasound scanning performed by the TRX circuit and the processor, wherein the latest ultrasound image is continuously displayed. Within the freeze mode, the position information of the ultrasound probe is continuously detected. If the ultrasound probe keeps in the static state under the freeze mode for a predefined period, the power saving mode is entered to suspend the processor.

[0009] In an embodiment of the present disclosure, when determined that the ultrasound probe is not in the static state under the freeze mode, the ultrasound scanning performed by the TRX circuit, the ultrasound probe and the processor is restarted, and the position information of the ultrasound probe is continuously detected afterward.

[0010] In an embodiment of the present disclosure, when determined that the ultrasound probe is not in the static state under the power saving mode, the processor is woke up from the suspension, and the ultrasound scanning is restarted. The position information of the ultrasound probe is continuously detected afterward.

[0011] The disclosure also includes an embodiment of an ultrasound apparatus performing a power management method. The ultrasound apparatus includes an ultrasound probe, a TRX circuit (includes AFE and pulser circuits), a position sensor, a power source, and a processor. The position sensor is disposed close to the ultrasound probe. The power source is connected to the TRX circuit, the sensor, and the processor. The processor controls the power source to supply power to the TRX circuit, and controls the TRX circuit to perform the ultrasound scanning. During the ultrasound scanning, the position sensor continuously detects the position information of the ultrasound probe, and the processor determines whether the ultrasound probe is in a static state accordingly. When determined that the ultrasound probe is in the static state during the ultrasound scanning, the processor controls the ultrasound apparatus to enter the freeze mode, such that the ultrasound scanning is stopped. When freeze mode, the sensor continuously detects the position information of the ultrasound probe, and the processor determines whether the ultrasound probe is still in the static state. If the processor determines the ultrasound probe is still in the static state under the freeze mode, the apparatus enters the power saving mode and the processor controls the power source to stop supplying the power to the TRX circuit.

[0012] According to the description above, the power management method detects position information of the ultrasound probe to determine whether the ultrasound probe is being operated or in the static state. When the ultrasound probe is in the static state, the ultrasound apparatus is controlled to enter the power saving mode and the power is stopped being supplied to the TRX circuit. By such, the power of the ultrasound apparatus is efficiently and accurately managed.

[0013] In order to make the aforementioned and other features and advantages of the disclosure comprehensible, several exemplary embodiments accompanied with figures are described in detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The accompanying drawings are included to provide a further understanding of the disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the disclosure and, together with the description, serve to explain the principles of the disclosure.

[0015] FIG. **1** is a schematic diagram illustrating an ultrasound apparatus according to an embodiment of the present disclosure.

[0016] FIG. **2** is a flowchart illustrating a power management method according to an embodiment of the present disclosure.

[0017] FIG. **3** is a flowchart illustrating a power management method according to another embodiment of the present disclosure.

DESCRIPTION OF EMBODIMENTS

[0018] Reference will now be made in detail to the present preferred embodiments of the disclosure, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

[0019] FIG. **1** is a schematic diagram illustrating an ultrasound apparatus according to an embodiment of the present disclosure. Referring to FIG. **1**, in the present embodiment of the present disclosure, the ultrasound apparatus **100** includes an ultrasound probe **120**, a transmit-and-receive (TRX) circuit **130** (includes the analog-front-end (AFE) and pulser), a position sensor **140**, a power source **150** and a processor **160**. In an embodiment of the disclosure, the ultrasound apparatus **100** may be implemented in an electronic apparatus with computation ability, such as a laptop computer, a tabular computer, a smart device and a mobile phone, but it is not limited herein. With the ultrasound apparatus **100**, ultrasound scanning may be performed, such that a plurality of ultrasound images are captured and displayed.

[0020] In an embodiment of the present disclosure, the ultrasound probe **120** is applied for emitting ultrasound waves and receiving echoes of the ultrasound waves. The ultrasound probe **120** may include a plurality of transducer elements which are horizontally arranged in a line.

[0021] In an embodiment of the present disclosure, the TRX circuit **130** is connected to the ultrasound probe **120** and communicates with the ultrasound probe **120** in the ultrasound apparatus **100**. In other words, the TRX circuit **130** performs the transmitting and receiving ultrasound signal by accessing the ultrasound probe **120**, controlled by the processor **160**. The TRX circuit **130** may be composed of multiple channels of analog-front-end (AFE) circuits and pulsers, multiple filters and multiple amplifiers, but it is not limited herein.

[0022] In an embodiment of the present disclosure, the position sensor **140** disposed on the ultrasound probe **120** may be, for example, an acceleration sensor, a gravity sensor (G sensor), a gyroscope, a digital compass, an electronic compass, or similar sensors, or a combination of the above sensors for detecting position information which may include acceleration, orientation, inclination angle, rotation angle and facing direction of the ultrasound probe **120**. Based on the position information from the position sensor **140**, movement of the ultrasound probe **120** may be deduced by the processor **160**.

[0023] In an embodiment of the present disclosure, the power source **150** in the ultrasound apparatus **100** may be, for example, battery or power supply unit (PSU), but it is not limited herein. The power source **150** is connected to the ultrasound probe **120**, the TRX circuit **130**, the position sensor **140** and the processor **160** for power supplement.

[0024] In an embodiment of the present disclosure, the processor **160** may include one or more of a field programmable gate array (FPGA), a programmable logic device (PLD), an application specific integrated circuit (ASIC), a central processing unit (CPU), a programmable general purpose or special purpose microprocessor, a micro-controller unit (MCU), or other similar devices or a combination thereof.

[0025] It should be noted that, in addition to the ultrasound probe **120**, the TRX circuit **130**, the position sensor **140**, the power source **150** and the processor **160** mentioned above, the ultrasound apparatus **100** may further include storage device, power button, display device, and user interface, but it is not limited herein. Furthermore, the ultrasound apparatus **100** may also include an input/output circuit (not shown) that provides ultrasound data captured by the ultrasound probe to a display, which may be external on a mobile phone, notebook, etc. The display may display the captured ultrasound images according to the ultrasound data.

[0026] FIG. **2** is a flowchart illustrating a power management method according to an embodiment of the present disclosure. In the present embodiment, the power management method is, for example, adapted to the ultrasound apparatus **100** shown in FIG. **1**, but it is not limited herein. The power management method of the present embodiment is described below with reference of various components of the ultrasound apparatus **100**.

[0027] Referring to FIG. **1** and FIG. **2**, when the ultrasound apparatus **100** is activated, power is supplied to the components of the ultrasound apparatus **100**. Especially, under the control of the processor **160**, power is supplied to the TRX circuit **130** (step S**205**). The ultrasound apparatus **100** may be activated through pressing the power button of the ultrasound apparatus **100**, but it is not limited herein. Further, the ultrasound scanning is performed (step S**210**) by the ultrasound apparatus **100**.

[0028] To be more specific, the ultrasound probe **120** and the TRX circuit **130** are controlled by the processor **160** for performing the ultrasound scanning to capture ultrasound images. The processor **160** controls the TRX circuit **130** and the ultrasound probe **120** to emit ultrasound waves and to detect echoes that are produced when the emitted ultrasound waves are reflected by objects. Further, according to the detected echoes, multiple ultrasound images are generated by the processor **160**'s calculation.

[0029] During the ultrasound scanning, the position sensor **140** disposed on the ultrasound probe **120** continuously detects position info illation of the ultrasound probe **120** (step S**215**). The position information which may include at least one of acceleration, orientation, inclination angle, rotation angle and facing direction of the ultrasound probe **120** is sent to the processor **160**, and the processor **160** determines whether the ultrasound probe **120** is in a static state during the ultrasound scanning (step S**220**) according to the detected position information.

[0030] In an embodiment of the present disclosure, the ultrasound probe **120** is determined to be in the static state when the processor **160** determines that movement of the ultrasound probe **120** (within a period) falls in a predefined range according to the detected position information. On the other hand, the ultrasound probe **120** is determined to be not in the static state when the processor **160** determines that the movement of the ultrasound probe **120** is greater than a predefined range. The period may be few seconds, a half minute or one minute, but it is not limited herein. However, in another embodiment of the present disclosure, the ultrasound probe **120** is determined as in the static state by the processor **160** only when the ultrasound probe **120** is held still for the period.

[0031] Referring to FIG. **1** and FIG. **2**, when determined that the ultrasound probe **120** is in the static state during the ultrasound scanning, the processor **160** controls the ultrasound apparatus **100** to enter a power saving mode (step S**225**), such that the ultrasound scanning is stopped. In other words, since the ultrasound probe **120** has not been moved for a period of time, the processor **160** temporarily suspends the ultrasound scanning. Specifically, in the power saving mode, the operations of the TRX circuit **130** and the ultrasound probe **120** are suspended.

[0032] By contrast, when determined that the ultrasound probe **120** is not in the static state during the ultrasound scanning, the processor **160** controls the the TRX circuit **130** and the ultrasound probe **120** to maintain the ultrasound scanning (step S**210**), and the sensor **140** continuously detects the position information of the ultrasound probe **120** (step S**215**).

[0033] Referring to FIG. **1** and FIG. **2**, within the power saving mode, the sensor **140** continuously detects the position information of the ultrasound probe **120** (step S**230**), and the processor **160** determines whether the ultrasound probe **120** is still in the static state under the power saving mode (step S**235**) according to the detected position information. When determined that the ultrasound probe **120** is still in the static state under the power saving mode, the processor **160** may recognize that the whole scanning process is finished, and controls the power source **150** to stop supplying the power to the TRX circuit **130** (step S**240**). Also, the processor **160** may control the power source **150** to stop supplying power to other components in the ultrasound apparatus **100**. By contrast, when determined that the ultrasound probe **120** is not in the static state under the power saving mode, the processor **160** restarts the ultrasound scanning (step S**210**), and the position sensor **140** continuously detects the position information of the ultrasound probe (step S**215**) during the ultrasound scanning.

[0034] FIG. **3** is a flowchart illustrating a power management method according to another embodiment of the present disclosure. In the present embodiment, the power management method is also, for example, adapted to the ultrasound apparatus **100** shown in FIG. **1**, but it is not limited herein. The difference between the power management methods shown in FIG. **2** and FIG. **3** is that, the power management method shown in FIG. **3** (step S**2202**) further includes a freeze mode.

[0035] To be more specific, when determined that the ultrasound probe is in the static state during the ultrasound scanning, before entering the power saving mode (step S**225**), the processor **160** controls the ultrasound apparatus **100** to enter a freeze mode (step S**2202**) to stop the ultrasound scanning performed by the TRX circuit **130** and the ultrasound probe **120**, while the latest ultrasound image is fixed and continuously displayed. Here, the processor **160** may first consider that the ultrasound probe **120** is temporarily stopped for scanning the same place, so even the ultrasound scanning is suspended, the latest ultrasound image captured by the ultrasound probe **120** will still be displayed for a while. In other words, the latest ultrasound image may still be transmitted (or output) to a display.

[0036] In addition, within the freeze mode, the sensor **140** continuously detects the position information of the ultrasound probe **120** (step S**2204**), and the processor **160** determines whether the ultrasound probe **120** is still in the static state under the freeze mode (step S**2206**) according to the detected position information. When determined that the ultrasound probe **120** is still in the static state under the freeze mode, the processor **160** controls the ultrasound apparatus **100** to enter the power saving mode (step S**225**) to turn off the power source to supply power to the TRX circuit and/or ultrasound probe. In contrast, when determined that the ultrasound probe **120** is not in the static state under the freeze mode, the processor **160** controls the TRX circuit **130** and the ultrasound probe **120** to restart the ultrasound scanning (step S**210**), and the sensor **140** continuously detects the position information of the ultrasound probe **120** (step S**215**) during the ultrasound scanning.

[0037] Other steps of the power management method shown in FIG. **3** could be referred from the power management method shown in FIG. **2**, so it is not repeated herein.

[0038] In summary, in the power management method and the ultrasound apparatus, through the detected position information of the ultrasound probe, whether the ultrasound probe is in the static state is determined. When the ultrasound probe is in the static state, the ultrasound apparatus is controlled to enter the power saving mode or the power is stopped being supply to the TRX circuit. By such, power of the ultrasound apparatus is efficiently and accurately managed.

[0039] It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the disclosed embodiments without departing from the scope or spirit of the disclosure. In view of the foregoing, it is intended that the disclosure cover modifications and variations of this disclosure provided they fall within the scope of the following claims and their equivalents.

What is claimed is:

1. A power management method, adapted to an ultrasound apparatus which has an ultrasound probe, a transmit-and-receive (TRX) circuit and a processor, the power management method comprising:

supplying power to the TRX circuit;

performing an ultrasound scanning by the TRX circuit, the ultrasound probe and the processor for capturing, calculating, and generating ultrasound images;

during the ultrasound scanning, continuously detecting position information of the ultrasound probe;

determining whether the ultrasound probe is in a static state during the ultrasound scanning according to the detected position information;

when determined that the ultrasound probe is in the static state during the ultrasound scanning, entering a power saving mode to stop ultrasound scanning and suspend the processor;

within the power saving mode, continuously detecting the position information of the ultrasound probe;

determining whether the ultrasound probe is still in the static state under the power saving mode according to the detected position information; and

when determined that the ultrasound probe is still in the static state under the power saving mode, stop supplying the power to the TRX circuit.

2. The power management method according to claim **1**, wherein the ultrasound probe is determined as in the static state when movement of the ultrasound probe within a period recognized from the detected position information falls in a predefined range.

3. The power management method according to claim **1**, further comprising:

when determined that the ultrasound probe is not in the static state during the ultrasound scanning, continuously performing the ultrasound scanning and continuously detecting the position information of the ultrasound probe.

4. The power management method according to claim **1**, wherein when determined that the ultrasound probe is in the static state during the ultrasound scanning, before entering the power saving mode, the power management method comprises:

entering a freeze mode to stop the ultrasound scanning performed by the TRX circuit and the ultrasound probe, wherein the latest ultrasound image is fixed and continuously displayed;

within the freeze mode, continuously detecting the position information of the ultrasound probe;

determining whether the ultrasound probe is still in the static state under the freeze mode according to the detected position information; and

when determined that the ultrasound probe is still in the static state under the freeze mode, entering the power saving mode to suspend the processor.

5. The power management method according to claim **4**, wherein when determined that the ultrasound probe is not in the static state under the freeze mode, restarting the ultrasound scanning performed by the TRX circuit and the ultrasound probe, and continuously detecting the position information of the ultrasound probe.

6. The power management method according to claim **1**, further comprising:

when determined that the ultrasound probe is not in the static state under the power saving mode, restarting the ultrasound scanning performed by the TRX circuit and the ultrasound probe, and continuously detecting the position information of the ultrasound probe.

7. An ultrasound apparatus, comprising:

an ultrasound probe;

an transmit-and-receive (TRX) circuit;

a position sensor, disposed on the ultrasound probe;

a power source connected to the ultrasound probe, the TRX circuit and the sensor; and

a processor, connected to the power source, controlling the power source to supply power to the TRX circuit, and controlling the TRX circuit and the ultrasound probe to perform an ultrasound scanning for capturing ultrasound images,

during the ultrasound scanning, the sensor continuously detects position information of the ultrasound probe, and the processor determines whether the ultrasound probe is in a static state during the ultrasound scanning according to the detected position information,

when determined that the ultrasound probe is in the static state during the ultrasound scanning, the processor controls the ultrasound apparatus to enter a power saving mode, such that the ultrasound scanning is stopped,

within the power saving mode, the sensor continuously detects the position information of the ultrasound probe, and the processor determines whether the ultrasound probe is still in the static state under the power saving mode according to the detected position information,

when determined that the ultrasound probe is still in the static state under the power saving mode, the processor controls the power source to stop supplying the power to the TRX circuit.

8. The ultrasound apparatus according to claim **7**, wherein the ultrasound probe is determined as in the static state by the processor when movement of the ultrasound probe within a period recognized from the detected position information falls in a predefined range.

9. The ultrasound apparatus according to claim **7**, wherein when determined that the ultrasound probe is not in the static state during the ultrasound scanning, the processor controls the TRX circuit, and the ultrasound probe to continuously perform the ultrasound scanning, and the sensor continuously detects the position information of the ultrasound probe.

10. The ultrasound apparatus according to claim **7**, wherein when determined that the ultrasound probe is in the static state during the ultrasound scanning, before entering the power saving mode, the processor controls the ultrasound apparatus to enter a freeze mode to stop the ultrasound scanning performed by the TRX circuit and the ultrasound probe, and the latest ultrasound image is continuously displayed,

within the freeze mode, the sensor continuously detects the position information of the ultrasound probe, and the processor determines whether the ultrasound probe is still in the static state under the freeze mode according to the detected position information,

when determined that the ultrasound probe is still in the static state under the freeze mode, the processor controls the ultrasound apparatus to enter the power saving mode.

11. The ultrasound apparatus according to claim **10**, wherein when determined that the ultrasound probe is not in the static state under the freeze mode, the processor controls the TRX circuit and the ultrasound probe to restart the ultrasound scanning, and the sensor continuously detects the position information of the ultrasound probe.

12. The ultrasound apparatus according to claim **7**, wherein when determined that the ultrasound probe is not in the static state under the power saving mode, the processor restarts the ultrasound scanning, and the sensor continuously detects the position information of the ultrasound probe.

* * * * *

patsnap

专利名称(译)	电源管理方法及其超声设备		
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[标]发明人	WU CHIEN HSIN LIU YING YI PENG SHENG CHANG LIU KUO PING		
发明人	WU, CHIEN-HSIN LIU, YING-YI PENG, SHENG-CHANG LIU, KUO-PING		
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摘要(译)

本公开涉及电力管理方法和使用该方法的超声设备。超声设备包括超声探头，TRX电路，位置传感器和处理器。在本公开中，向超声设备供电，并且执行超声扫描。在超声扫描期间，位置传感器连续检测超声探头的位置信息。确定超声波探头在超声波扫描期间是否处于静止状态。当在超声扫描期间确定超声探头处于静止状态时，进入省电模式，使得超声扫描停止。在省电模式下，连续检测位置信息。确定超声波探头是否在省电模式下仍处于静止状态。当确定超声探头在省电模式下仍处于静止状态时，不向TRX电路供电。