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(54) **NON-CONTACT VITAL-SIGN MONITORING SYSTEM AND METHOD**

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G01S 7/00 (2006.01)

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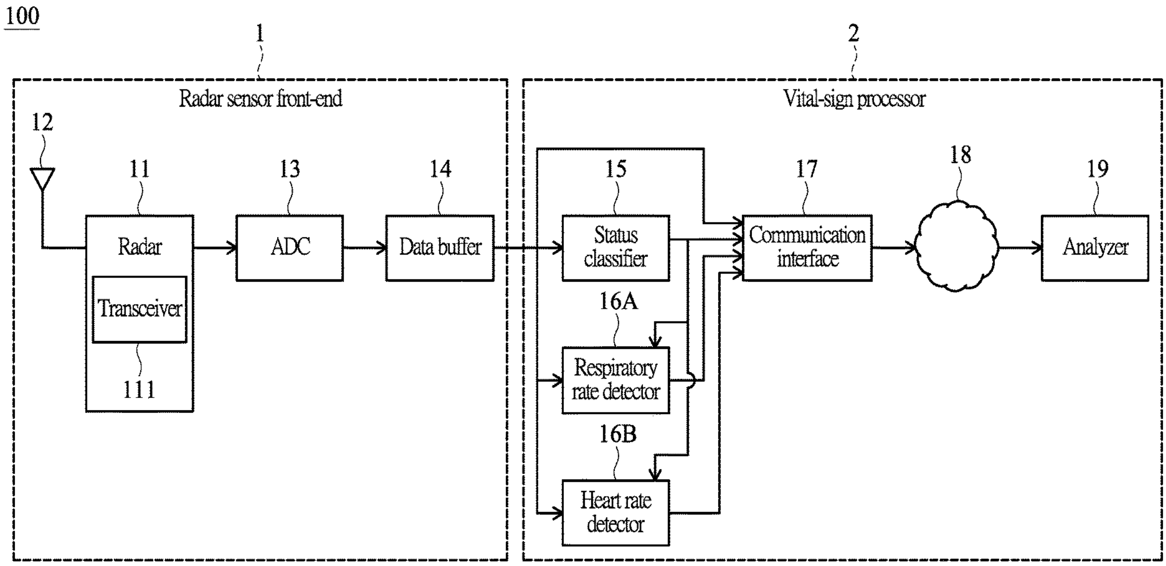
(57) **ABSTRACT**

A non-contact vital-sign monitoring system having a radar disposed in vicinity of a monitored subject includes a data buffer storing output signals of the radar sampled in sequence during a predetermined period; a status classifier determining status of the monitored subject; and a vital-sign detector determining a vital sign of the monitored subject according to the output signals of stationary status.



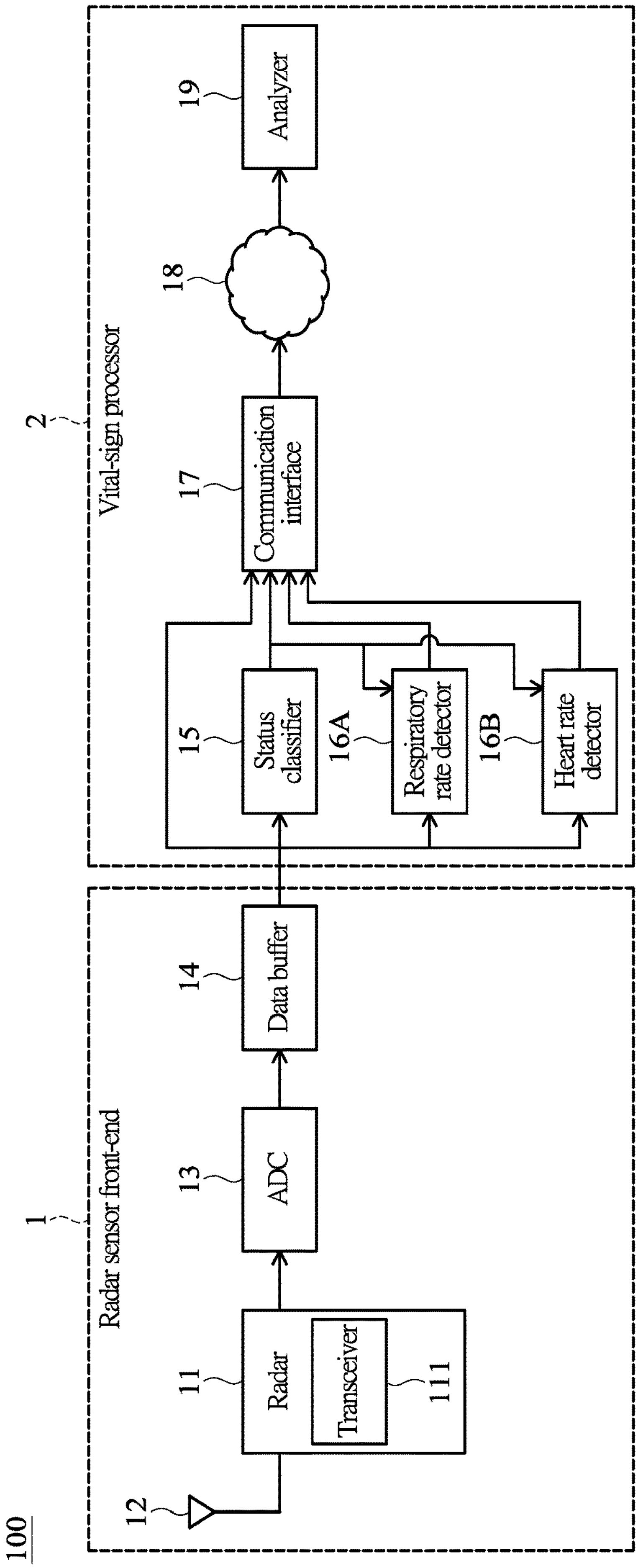

100
1
Radar sensor front-end
12
11
Radar
Transceiver
111
13
ADC
14
Data buffer
2
Vital-sign processor
15
Status classifier
16A
Respiratory rate detector
16B
Heart rate detector
17
Communication interface
18
19
Analyzer

FIG. 1

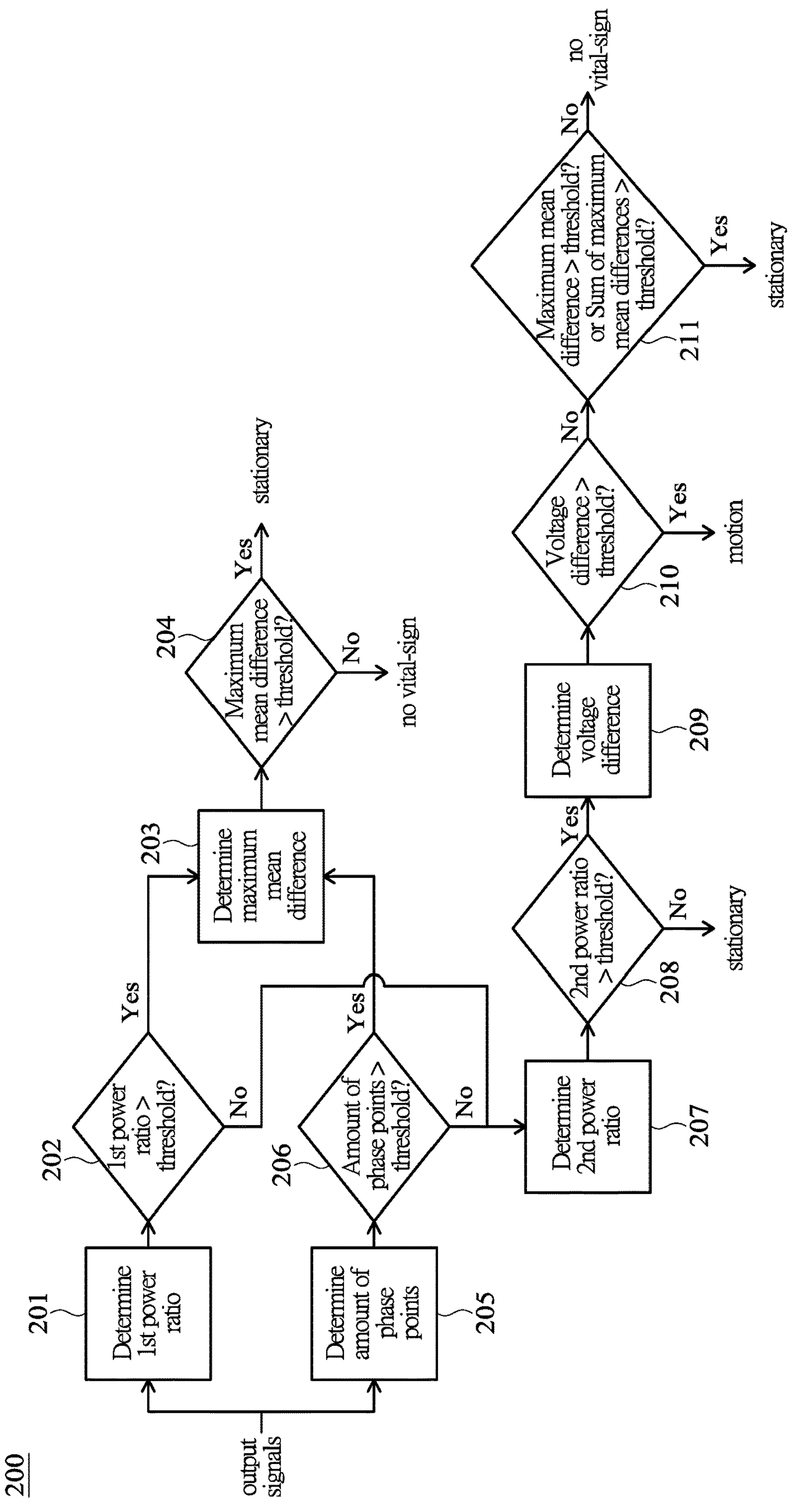

200
output signals
Determine 1st power ratio
201
1st power ratio > threshold?
202
Yes
No
Determine maximum mean difference
203
Maximum mean difference > threshold?
204
Yes
stationary
No
no vital-sign
Determine amount of phase points
205
Amount of phase points > threshold?
206
Yes
No
Determine 2nd power ratio
207
2nd power ratio > threshold?
208
Yes
No
stationary
Determine voltage difference
209
Voltage difference > threshold?
210
Yes
motion
No
Maximum mean difference > threshold? or Sum of maximum mean differences > threshold?
211
Yes
stationary
No
no vital-sign

FIG. 2

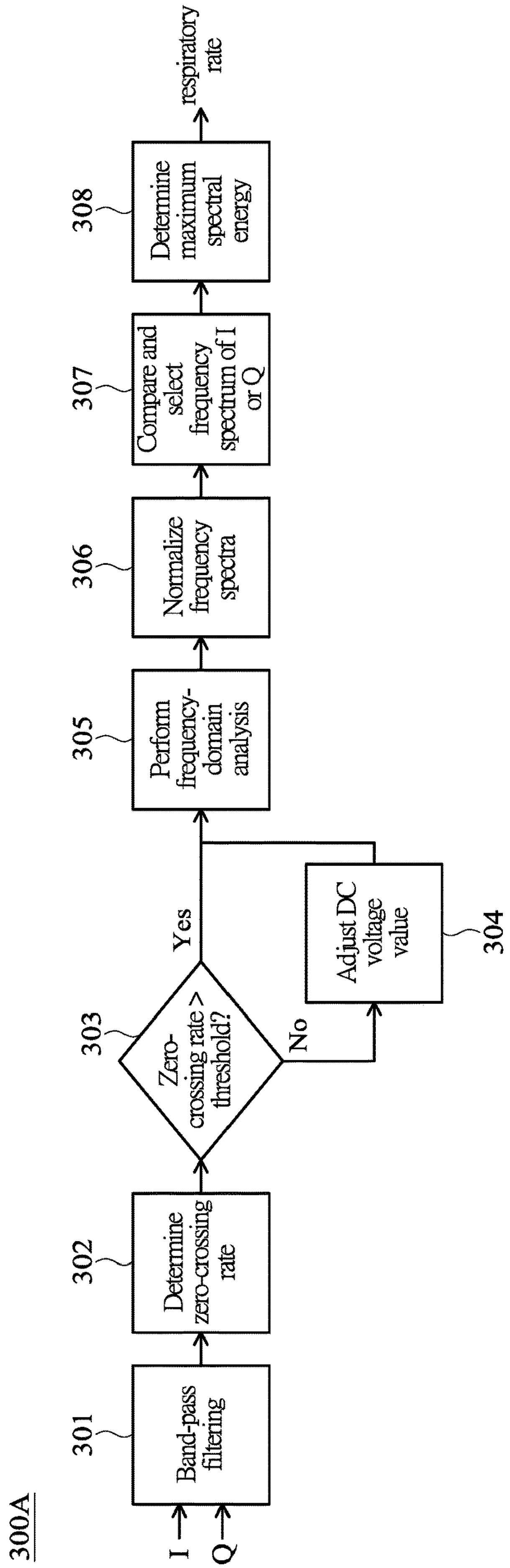

300A
I
Q
301
Band-pass filtering
302
Determine zero-crossing rate
303
Zero-crossing rate > threshold?
Yes
No
304
Adjust DC voltage value
305
Perform frequency-domain analysis
306
Normalize frequency spectra
307
Compare and select frequency spectrum of I or Q
308
Determine maximum spectral energy
respiratory rate

FIG. 3A

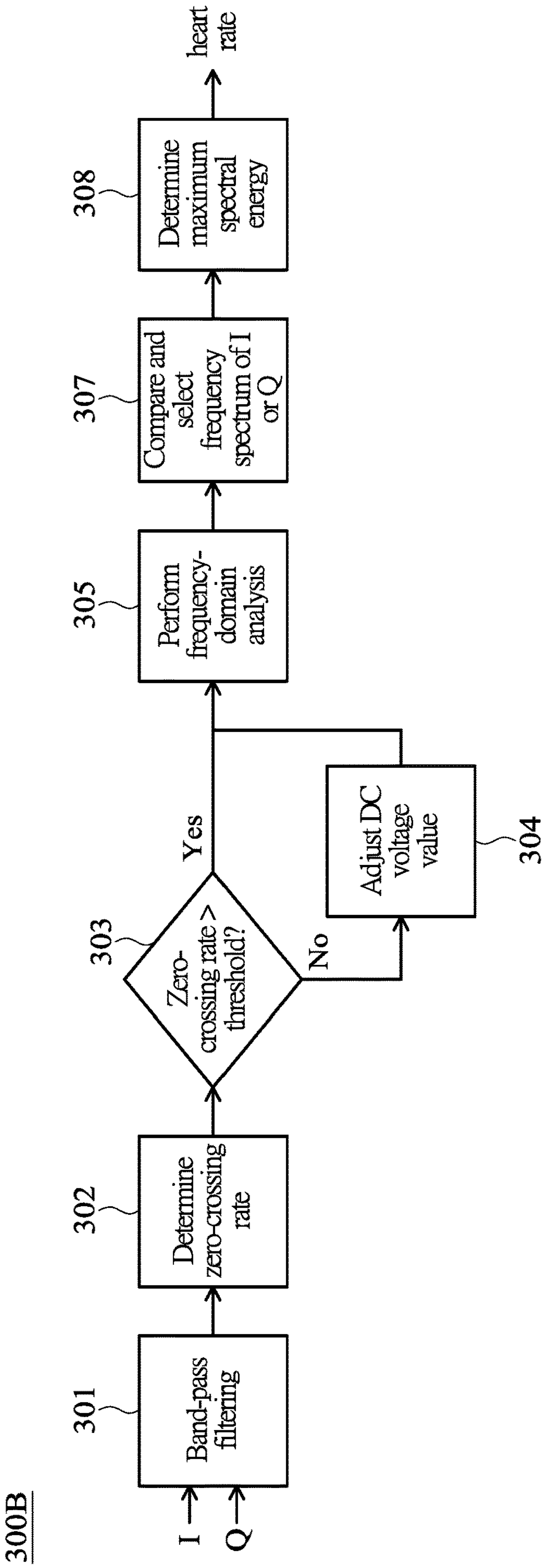

300B
I
Q
301
Band-pass filtering
302
Determine zero-crossing rate
303
Zero-crossing rate > threshold?
Yes
No
304
Adjust DC voltage value
305
Perform frequency-domain analysis
307
Compare and select frequency spectrum of I or Q
308
Determine maximum spectral energy
heart rate

FIG. 3B

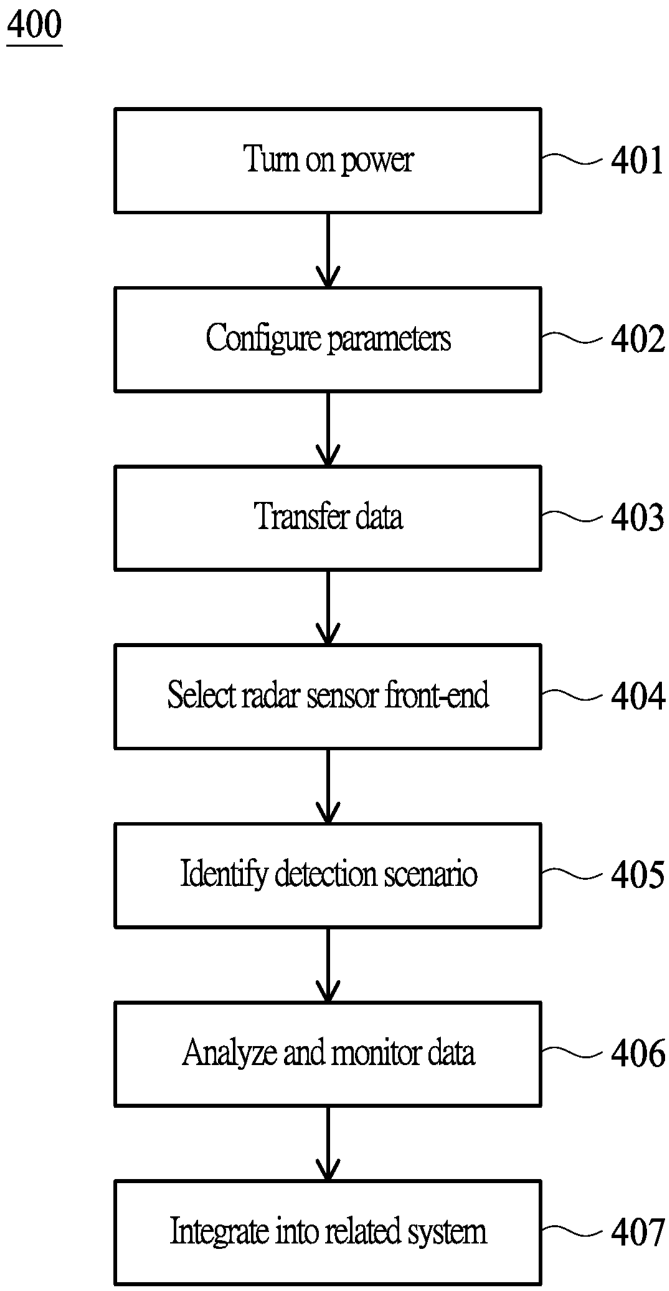

400
Turn on power
401
Configure parameters
402
Transfer data
403
Select radar sensor front-end
404
Identify detection scenario
405
Analyze and monitor data
406
Integrate into related system
407

FIG. 4

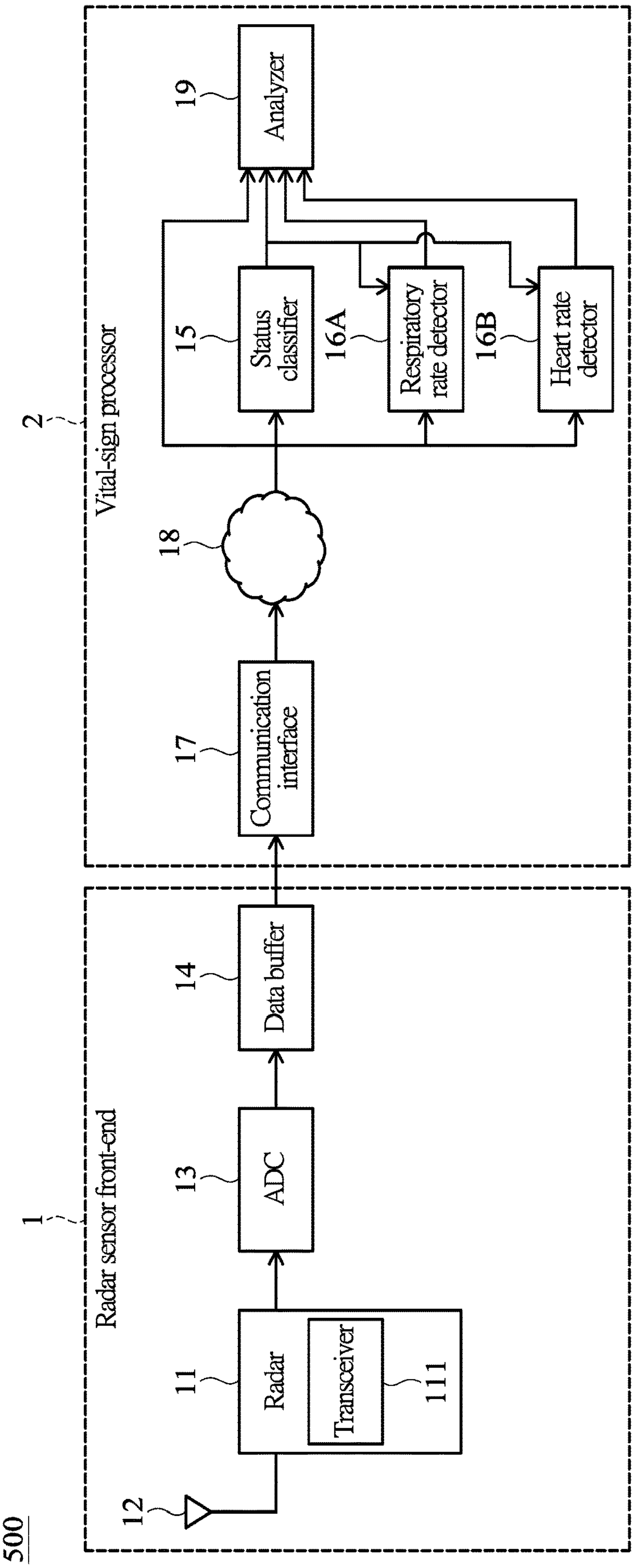

500
1
Radar sensor front-end
12
11
Radar
Transceiver
111
13
ADC
14
Data buffer
2
Vital-sign processor
17
Communication interface
18
15
Status classifier
16A
Respiratory rate detector
16B
Heart rate detector
19
Analyzer

FIG. 5

NON-CONTACT VITAL-SIGN MONITORING SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority of Taiwan Patent Application No. 107146296, filed on Dec. 21, 2018, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention generally relates to a monitoring system, and more particularly to a non-contact vital-sign monitoring system and method.

2. Description of Related Art

[0003] Body temperature (BT), blood pressure (BP), heart rate (HR) and respiratory rate (RR) are four primary vital signs. The detection and measurement of the vital signs may be used to evaluate health condition or a clue to illness of a person.

[0004] Most conventional health monitoring devices are contact type, and contact with the body of a monitored subject via wires. Accordingly, the contact health monitoring devices would restrict the movement of the monitored subject. Moreover, the contact health monitoring devices may only be operated by trained personnel.

[0005] A professional is generally required to make observation and recording while using conventional (contact or non-contact) health monitoring devices. Due to limited manpower, health measure can only be made at intervals. Therefore, a detecting chance may probably be lost in case of emergency, and an opportunity to save life may be missed. A need has thus arisen to propose an all-day non-contact vital-sign monitoring system.

SUMMARY OF THE INVENTION

[0006] In view of the foregoing, it is an object of the embodiment of the present invention to provide a non-contact vital-sign monitoring system and method for detecting a respiratory rate and a heart rate.

[0007] According to one embodiment, a non-contact vital-sign monitoring system having a radar disposed in vicinity of a monitored subject includes a data buffer, a status classifier and a vital-sign detector. The data buffer stores output signals of the radar sampled in sequence during a predetermined period. The status classifier determines status of the monitored subject according to the output signals. The vital-sign detector determines a vital sign of the monitored subject according to the output signals of stationary status.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** shows a block diagram illustrating a non-contact vital-sign monitoring system according to one embodiment of the present invention;

[0009] FIG. **2** shows a flow diagram illustrating a non-contact vital-sign monitoring method for determining vital-sign status according to one embodiment of the present invention;

[0010] FIG. **3**A shows a flow diagram illustrating a method of detecting a respiratory rate according to one embodiment of the present invention;

[0011] FIG. **3**B shows a flow diagram illustrating a method of detecting a heart rate according to one embodiment of the present invention;

[0012] FIG. **4** shows a flow diagram illustrating a non-contact vital-sign monitoring method according to one embodiment of the present invention; and

[0013] FIG. **5** shows a block diagram illustrating a non-contact vital-sign monitoring system according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] FIG. **1** shows a block diagram illustrating a non-contact vital-sign monitoring system **100** adaptable to monitoring a vital sign, such as a heart rate or a respiratory rate, according to one embodiment of the present invention.

[0015] In the embodiment, the non-contact vital-sign monitoring system (monitoring system hereinafter) **100** may include a radar sensor front-end **1** that may include a radar **11**, such as a continuous-wave (CW) radar, disposed in vicinity of a monitored subject covered by the detection range of the radar **11**. In one embodiment, the radar **11** may be disposed above the chest of the monitored subject lying on a bed. In another embodiment, the radar **11** may be disposed in other orientation such as below or beside the bed. In one embodiment, the radar **11** may include an ultra-wideband (UWB) radar such as frequency modulated continuous waveform (FMCW) radar. The radar sensor front-end **1** of the monitoring system **100** may include an antenna **12** electrically coupled to the radar **11**, and configured to transmit radio-frequency (RF) signals and to receive reflected RF signals. The radar **11** of the embodiment may include a transceiver **111** configured to generate baseband output signals according to the reflected RF signals. In another embodiment, the antenna **12** may be integrated with the radar **11**. In a further embodiment, the radar sensor front-end **1** may include multiple radars **11** disposed at different locations.

[0016] The radar sensor front-end **1** of the monitoring system **100** of the embodiment may include an analog-to-digital converter (ADC) **13** coupled to receive the (analog) output signals from the radar **11**, and configured to convert the analog output signals into digital output signals. In the embodiment, the output signal of the radar **11** may include an in-phase polarization signal (in-phase signal hereinafter) I and a quadrature polarization signal (quadrature signal hereinafter) Q.

[0017] The radar sensor front-end **1** of the monitoring system **100** may include a data buffer **14** configured to store the output signals sampled in sequence during a predetermined period. For example, the data buffer **14** may store eight pieces of output signals sampled at intervals each of 2.5 seconds. Accordingly, the data buffer **14** may store the output signals spanning a period of 20 seconds. The spanning period, for example, of 10, 30 or 60 seconds may be set according to specific applications. The sampling interval may be determined based on response time. The shorter the sampling interval is, the more rapidly the monitoring system **100** responds.

[0018] In the embodiment, the monitoring system **100** may include a vital-sign processor **2** that may include a status classifier **15** configured to determine status of the monitored subject according to the output signals of the radar **11**. In the embodiment, status of the monitored subject may, but not necessarily, be classified into three types: stationary, motion and no vital-sign. Stationary status may indicate that the monitored subject sleeps or rests, motion status may indicate that the monitored subject turns or moves, and no vital-sign status may indicate that the monitored subject is not currently on the bed. Specifically, for example, stationary status may indicate that the monitored subject turns to a posture during sleep, stays still while watching television, or slightly trembles; motion status may indicate that the monitored subject moves on bed or off bed, or moves around the bed; and no vital-sign status may indicate that the monitored subject is no longer vital. In another embodiment, the status classifier **15** may receive output signals of multiple radars **11** disposed at different locations.

[0019] FIG. **2** shows a flow diagram illustrating a non-contact vital-sign monitoring method (method hereinafter) **200** for determining vital-sign status and adaptable to the status classifier **15** of FIG. **1** according to one embodiment of the present invention. In step **201**, a first power ratio in frequency domain is determined according to the output signals of the radar **11**, for example, by using fast Fourier transform (FFT) algorithm. In the embodiment, the first power ratio is defined as a ratio of power in a predetermined (first) frequency range (e.g., 12.5-25 Hz) to total power, and may be expressed as:

$$\text{first power ratio}=P_{fr1}/P_t$$

where P_{fr1} represents power in the predetermined (first) frequency range, and P_t represents total power (in a full frequency range).

[0020] Next, in step **202**, it is determined whether the first power ratio is greater than a predetermined (first) threshold.

[0021] If determination in step **202** is positive, the flow goes to step **203** to determine a maximum mean difference, which represents a maximum among a plurality of mean differences. In the embodiment, the data buffer **14** may have a total mean M. The data buffer **14** may be divided into a plurality of (e.g., m) blocks, each having a divisional mean DM_1-DM_m. The mean difference is defined as (the absolute value of) a difference of the divisional mean and the total mean, that is, DM_x-M, x is 1 to m. The maximum mean difference may be expressed as:

$$\text{maximum mean difference}=\max\{\text{abs}[(DM_1,DM_2,\ldots DM_m)-(M,M,\ldots M)\}$$

where abs( ) represents absolute value function, and max( ) represents maximum value function.

[0022] In step **204**, it is determined whether the maximum mean difference is greater than a predetermined (second) threshold. If determination in step **204** is positive, the monitored subject is determined or predicted as being in stationary status; otherwise the monitored subject is determined or predicted as being in no vital-sign status.

[0023] On the other hand, the method **200** for determining vital-sign status of the embodiment may include steps **205-206** to be executed concurrently with step **201-202**. In step **205**, an amount of phase point is determined according to the output signals of the radar **11**. In the embodiment, the in-phase signal I, the quadrature signal Q and phase φ may have the following relationship:

$$I(n)=A_I(n)\cos(p(n)+\theta)$$

$$Q(n)=A_Q(n)\sin(p(n)+\theta)$$

$$\varphi=\arctan[Q(n)/I(n)]$$

[0024] In the embodiment, if the phase φ is within a predetermined range (e.g., between 44.5° and 45.51°), it is then numbered among the phase points. Next, in step **206**, it is determined whether the amount of phase points is greater than a predetermined (third) threshold.

[0025] If determination in step **206** is positive, the flow goes to step **203** to determine a maximum mean difference. In step **204**, it is determined whether the maximum mean difference is greater than a predetermined (second) threshold. If determination in step **204** is positive, the monitored subject is determined or predicted as being in stationary status; otherwise the monitored subject is determined or predicted as being in no vital-sign status.

[0026] If determination in step **202** or step **206** is negative, the flow goes to step **207** to determine a second power ratio in frequency domain according to the output signals of the radar **11**, for example, by using fast Fourier transform (FFT) algorithm. In the embodiment, the second power ratio is defined as a ratio of power in a predetermined (second) frequency range (e.g., 3-25 Hz) to total power, and may be expressed as:

$$\text{second power ratio}=P_{fr2}/P_t$$

where P_{fr2} represents power in the predetermined (second) frequency range, and P_t represents total power (in a full frequency range). It is noted that the predetermined second frequency range may be equal to, or different from the predetermined first frequency range.

[0027] Next, in step **208**, it is determined whether the second power ratio is greater than a predetermined (fourth) threshold, which may be equal to, or different from the predetermined (first) threshold. If determination in step **208** is negative, the monitored subject is determined or predicted as being in stationary status; otherwise the flow goes to step **209**. If the predetermined second frequency range is equal to the predetermined first frequency range, and the predetermined fourth threshold is equal to the predetermined first threshold, steps **207-208** may be omitted for the reason that steps **207-208** are duplicates of steps **201-202**.

[0028] In step **209**, a voltage difference, such as point-to-point or peak-to-peak voltage difference, of the output signal is determined. Next, in step **210**, it is determined whether the voltage difference is greater than a predetermined (fifth) threshold. If determination in step **210** is positive, the monitored subject is determined or predicted as being in motion status; otherwise the flow goes to step **211**.

[0029] In step **211**, it is determined whether the maximum mean difference is greater than a predetermined (second) threshold (similar to step **204**), or whether a sum of maximum mean differences is greater than a predetermined (sixth) threshold. If at least one of determinations is positive, the monitored subject is determined or predicted as being in stationary status; otherwise the monitored subject is determined or predicted as being in no vital-sign status. In the embodiment, the sum of maximum mean differences is a sum of maximum mean difference of the in-phase signal I and maximum mean difference of the quadrature signal Q.

[0030] Referring back to FIG. **1**, the vital-sign processor **2** of the monitoring system **100** of the embodiment may include a respiratory rate detector **16**A coupled to receive the status determined by the status classifier **15** and configured to obtain a respiratory rate of the monitored subject according to the output signals (including the in-phase signal I and the quadrature signals Q) of the radar **11** of stationary status. As stated above, the data buffer **14** may store eight pieces of output signals sampled at intervals each of 2.5 seconds in the embodiment. While determining the respiratory rate, if the monitored subject is determined or predicted as being not in stationary status, corresponding data in the data buffer **14** may be set a predetermined value, such as a direct-current (DC) voltage value of the output signal. In another embodiment, the predetermined value may be a fixed waveform composed of one or more frequencies. In a further embodiment, the predetermined value may be a linear-nonlinear computation result according to preceding data stored in the data buffer **14**.

[0031] FIG. **3**A shows a flow diagram illustrating a method **300**A of detecting a respiratory rate adaptable to the respiratory rate detector **16**A of FIG. **1** according to one embodiment of the present invention. In step **301**, the output signals (including the in-phase signals I and the quadrature signals Q) of the radar **11** are subjected to band-pass filtering by a band-pass filter, thereby generating filtered signals. In one embodiment, a passband frequency range of the band-pass filter corresponds to a frequency range of respiratory rate, for example but not limited to, 0.16-0.8 Hz.

[0032] In step **302**, a zero-crossing rate in time domain is determined according to the filtered signals from the band-pass filter. In the embodiment, zero-crossing refers to an intersection between an alternative-current (AC) component of the output signal and a direct-current (DC) component of the output signal. When the output signal is normal, the zero-crossing rate is large. However, when the output signal is abnormal (e.g., the AC component shifts up or down), the zero-crossing rate becomes small.

[0033] Next, in step **303**, it is determined whether the zero-crossing rate is greater than a predetermined (seventh) threshold. If determination in step **303** is negative (indicating that the AC component of the output signal shifts), the flow goes to step **304** to adjust a DC voltage value of the output signal.

[0034] If determination in step **303** is positive or step **304** finishes, the flow goes to step **305** to perform frequency-domain analysis, according to which a frequency spectrum (of energy distribution) of the in-phase signal I and a frequency spectrum (of energy distribution) of the quadrature signal Q are obtained. Next, in step **306**, the frequency spectra of the in-phase signal I and the quadrature signal Q are normalized.

[0035] In step **307**, a maximum spectral energy of the in-phase signal I and a maximum spectral energy of the quadrature signal Q are compared. Accordingly, the frequency spectrum of the in-phase signal I or the frequency spectrum of the quadrature signal Q is selected. In other words, the frequency spectrum of the in-phase signal I is selected if the maximum spectral energy of the in-phase signal I is greater than the maximum spectral energy of the quadrature signal Q; otherwise the frequency spectrum of the quadrature signal Q is selected. In step **308**, a maximum spectral energy of the selected frequency spectrum is determined, and a corresponding frequency is determined as the respiratory rate.

[0036] Referring back to FIG. **1**, the monitoring system **100** of the embodiment may include a heart rate detector **16**B coupled to receive the status determined by the status classifier **15** and configured to obtain a heart rate of the monitored subject according to the output signals (including the in-phase signal I and the quadrature signals Q) of the radar **11** of stationary status.

[0037] FIG. **3**B shows a flow diagram illustrating a method **300**B of detecting a heart rate adaptable to the heart rate detector **16**B of FIG. **1** according to one embodiment of the present invention. The flow of FIG. **3**B is similar to the flow of FIG. **3**A, and corresponding steps are thus designated with the same numerals, difference of which will be described below.

[0038] In step **301**, a passband frequency of the method **300**B for detecting the heart rate is higher than (or equal to) the passband frequency of the method **300**A for detecting the respiratory rate. In one embodiment, a passband frequency range of the method **300**B for detecting the heart rate corresponds to a frequency range of heart rate, for example but not limited to, 0.7-3 Hz. In the method **300**B for detecting the heart rate, normalization on the frequency spectra in step **306** may be omitted. In step **308**, a maximum spectral energy of the selected frequency spectrum is determined, and a corresponding frequency is determined as the heart rate.

[0039] Referring back to FIG. **1**, the vital-sign processor **2** of the monitoring system **100** of the embodiment may include a communication interface **17** configured to transfer the output signals of the radar **11**, the status determined by the status classifier **15**, the respiratory rate of the monitored subject detected by the respiratory rate detector **16**A and/or the heart rate of the monitored subject detected by the heart rate detector **16**B to an analyzer **19** via a network **18** (e.g., the Internet). The communication interface **17** may be a wired communication interface such as universal asynchronous receiver-transmitter (UART), Inter-Integrated Circuit (I2C), Serial Peripheral Interface (SPI), Controller Area Network (CAN), Recommended Standard (RS) 232 or Recommended Standard (RS) 422; may be a wireless communication interface such as Wireless Sensor Network (e.g., EnOcean, Bluetooth or ZigBee); may be a cellular network such as second generation (2G), third generation (3G), Long-Term Evolution (LTE), or fifth generation (5G); may be a wireless local network such as WLAN or Worldwide Interoperability for Microwave Access (WiMAX); or may be a short range point-to-point communication such as Radio-frequency identification (RFID), EnOcean or Near-field communication. In another embodiment, the communication interface **17** is configured to transfer the output signals of the radar **11**, the status determined by the status classifier **15**, the respiratory rate of the monitored subject detected by the respiratory rate detector **16**A and/or the heart rate of the monitored subject detected by the heart rate detector **16**B to the analyzer **19** via a signal cable.

[0040] FIG. **4** shows a flow diagram illustrating a non-contact vital-sign monitoring method **400** according to one embodiment of the present invention. In step **401**, power of the radar **11**, the ADC **13**, the data buffer **14**, the status classifier **15**, the respiratory rate detector **16**A and the heart rate detector **16**B is turned on. In the embodiment, the radar **11**, the ADC **13**, the data buffer **14**, the status classifier **15**, the respiratory rate detector **16**A and the heart rate detector **16**B may be implemented, for example, by a digital signal processor (DSP).

[0041] In step **402**, primary parameters (e.g., division of the data buffer **14**, the (first) frequency range (step **201**), the (second) frequency range (step **207**) and the passband frequency range (step **301**)) of the data buffer **14**, the status classifier **15**, the respiratory rate detector **16**A and the heart rate detector **16**B are configured. In step **403**, the communication interface **17** transfers the output signals, the status, the respiratory rate and/or the heart rate to the analyzer **19** (which may be disposed in cloud) via the network **18**.

[0042] Next, in step **404**, the analyzer **19** may select one among plural radar sensor front-ends **1**. In step **405**, a detection scenario (e.g., the monitored subject lies down on one's back, reclines, or lies down on one's side) is identified. In step **406**, the transferred data of the radar sensor front-end **1** are analyzed and monitored. A warning may be issued to predetermined personnel or units when an emergent situation happens. In step **407**, analysis result may be integrated into a related system (e.g., hospital system) for obtaining general and adequate judgement and comprehension.

[0043] FIG. **5** shows a block diagram illustrating a non-contact vital-sign monitoring system (monitoring system hereinafter) **500** according to another embodiment of the present invention. The monitoring system **500** of FIG. **5** is similar to the monitoring system **100** of FIG. **1** with the following exception. In the embodiment, the communication interface **17** of the monitoring system **500** may receive the output signals of the radar **11** via the data buffer **14**, and the output signals of the radar **11** may then be transferred to the status classifier **15**, the respiratory rate detector **16**A and/or the heart rate detector **16**B via the network **18** (or directly). Accordingly, in the present embodiment, only the radar sensor front-end **1** (i.e., the radar **11**, the antenna **12**, the ADC **13** and the data buffer **14**), but not the status classifier **15**, the respiratory rate detector **16**A and the heart rate detector **16**B, need be installed in each ward.

[0044] Although specific embodiments have been illustrated and described, it will be appreciated by those skilled in the art that various modifications may be made without departing from the scope of the present invention, which is intended to be limited solely by the appended claims.

What is claimed is:

1. A non-contact vital-sign monitoring system having a radar disposed in vicinity of a monitored subject, the system comprising:

a data buffer storing output signals of the radar sampled in sequence during a predetermined period;

a status classifier determining status of the monitored subject according to the output signals; and

a vital-sign detector determining a vital sign of the monitored subject according to the output signals of stationary status.

2. The system of claim **1**, wherein the radar comprises a continuous-wave radar or an ultra-wideband radar.

3. The system of claim **1**, wherein corresponding data in the data buffer is set a predetermined value when the monitored subject is not in stationary status.

4. The system of claim **1**, wherein the status classifier determines status of the monitored subject according to one or more power ratios, an amount of phase points or one or more voltage differences of the output signals.

5. The system of claim **1**, wherein the vital-sign detector comprises a respiratory rate detector.

6. The system of claim **5**, wherein the respiratory rate detector receives the status determined by the status classifier and determines a respiratory rate of the monitored subject according to a frequency associated with a maximum spectral energy of the output signals of stationary status.

7. The system of claim **1**, wherein the vital-sign detector comprises a heart rate detector.

8. The system of claim **7**, wherein the heart rate detector receives the status determined by the status classifier and determines a heart rate of the monitored subject according to a frequency associated with a maximum spectral energy of the output signals of stationary status.

9. The system of claim **1**, further comprising:

an analyzer; and

a communication interface that transfers the output signals, the status or the vital sign to the analyzer.

10. A non-contact vital-sign monitoring method, comprising:

determining a first power ratio in frequency domain according to a plurality of buffered output signals of a radar that is disposed in vicinity of a monitored subject, and determining whether the first power ratio is greater than a predetermined first threshold;

determining an amount of phase points according to the output signals, and determining whether the amount of phase points is greater than a predetermined third threshold;

determining a maximum mean difference according to the output signals if the first power ratio is greater than the first threshold and the amount of phase points is greater than the third threshold, and determining whether the maximum mean difference is greater than a predetermined second threshold;

determining a second power ratio in frequency domain according to the output signals if the first power ratio is not greater than the first threshold or the amount of phase points is not greater than the third threshold, and determining whether the second power ratio is greater than a predetermined fourth threshold; and

determining a voltage difference according to the output signals, and determining whether the voltage difference is greater than a predetermined fifth threshold.

11. The method of claim **10**, wherein the monitored subject is determined as being in stationary status if the maximum mean difference is greater than the second threshold, otherwise the monitored subject is determined as being in no vital-sign status.

12. The method of claim **10**, wherein the monitored subject is determined as being in stationary status if the second power ratio is not greater than the fourth threshold.

13. The method of claim **10**, wherein the monitored subject is determined as being in motion status if the voltage difference is greater than the fifth threshold.

14. The method of claim **10**, further comprising;

determining a sum of a plurality of the maximum mean differences according to the output signals, and determining whether the sum of the maximum mean differences is greater than a predetermined sixth threshold.

15. The method of claim **14**, wherein the monitored subject is determined as being in stationary status if the voltage difference is not greater than the fifth threshold and the sum of the maximum mean differences is greater than the sixth threshold, otherwise the monitored subject is determined as being in no vital-sign status.

16. A non-contact vital-sign monitoring method, comprising:

band-pass filtering output signals of a radar to generate filtered signals including in-phase signals and quadrature signals;

determining a zero-crossing rate in time domain according to the filtered signals, and determining whether the zero-crossing rate is greater than a predetermined threshold;

obtaining a frequency spectrum of the in-phase signals and a frequency spectrum of the quadrature signals according to the filtered signals;

selecting the frequency spectrum of the in-phase signals or the frequency spectrum of the quadrature signals as a selected frequency spectrum by comparing a maximum spectral energy of the in-phase signals and a maximum spectral energy of the quadrature signals; and

determining a maximum spectral energy of the selected frequency spectrum, a frequency associated with the maximum spectral energy of the selected frequency spectrum being determined as a vital sign.

17. The method of claim **16**, further comprising:

adjusting a direct-current voltage value of the output signals if the zero-crossing rate is not greater than the threshold.

18. The method of claim **16**, further comprising:

normalizing the frequency spectrum of the in-phase signals and the frequency spectrum of the quadrature signals.

19. The method of claim **16**, wherein the band-pass filtering has a passband frequency range corresponding to a frequency range of respiratory rate, and the vital sign represents a respiratory rate of a monitored subject; or the band-pass filtering has a passband frequency range corresponding to a frequency range of heart rate, and the vital sign represents a heart rate of the monitored subject.

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专利名称(译)	非接触生命体征监测系统及方法		
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摘要(译)

一种非接触生命体征监测系统，其雷达布置在被监测对象附近，其包括数据缓冲器，其存储在预定时间段内按顺序采样的雷达输出信号； 状态分类器，确定被监视对象的状态； 生命体征检测器根据静止状态的输出信号确定被监测者的生命体征。