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

SYSTEM ZUR KONTAKTLOSEN ÜBERWACHUNG VON VITALZEICHEN

SYSTÈME DE SURVEILLANCE DE SIGNES VITAUX SANS CONTACT

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Description

[0001] This invention generally relates to a non-contact vital sign monitoring system comprising the features of the preamble portion of claim 1, and more particularly to a non-contact vital sign monitoring system able to cancel a random body movement effect.

[0002] Vital sign monitoring system, extensively applied to healthcare and fitness equipment, can track health and exercise of a biological subject by capturing and analyzing the changes in vital signs.

[0003] In general, there are two types of conventional vital sign monitoring system, contact type and non-contact type. The contact type vital sign monitoring system has to contact the subject's skin for a long time for accurate detection of the subject's vital signs, and the subject's moving range may be limited by the wires connected to the contact type vital sign monitoring system, causing the subject to feel uncomfortable during monitoring. In contrast, the non-contact vital sign monitoring system transmits wireless signals to the subject, the subject's vital signs can be detected according to the Doppler shift of the reflected signals. However, the reflected signals caused by body movement of the subject will also cause Doppler shift to affect the vital sign monitoring. Therefore, how to cancel the random body movement effect is a key point for developing the non-contact vital sign monitoring system.

[0004] A non-contact vital sign monitoring system according to the preamble portion of claim 1 is known from US 2012/0209087 A1. The known system is able to cancel random body movement. In order to cancel out random body movement, the corresponding signals need to be anisotropic, which imposes limitations on the spatial arrangement of the system and implies the need for frequency adjustments when signals are received from the same side of a subject. The subject's vital signs are therefore difficult to detect by the system when the subject stands against a wall or lays on a bed.

[0005] Another vital sign monitoring system of this type is known from US 2010/0198083.

[0006] The object the present invention is to provide an alternative non-contact vital sign monitoring system, which combines a less spacious system layout and less complicated handling for determining precise vital sign signal.

This technical problem is solved by the subject matter of claim 1. Advantageous embodiments are indicated in further claims.

[0007] The present invention is configured to have two radar devices at the same side of a biological subject to transmit wireless signals to the subject and receive the reflected signals from the subject via two different gain antennas for detecting Doppler shift in which the components due to body movement are approximately equal in magnitude and out of phase with each other, and the components due to vital signs are significantly different in magnitude. The Doppler shift components caused by

body movement will be cancelled out when the two radar devices are in the self- and mutual-injection locking state, and the subject's vital signs can be detected because the Doppler shift components caused by vital signs will not be cancelled out.

[0008] The first and second antennas transmit the first and second transmission signals to the subject and receive the first and second reflected signals from the subject, respectively. When the first reflected signal is received by the first antenna and then delivered to the first radar device and the second reflected signal is received by the second antenna and then delivered to the second radar device, the two radar devices will enter the self-injection locking state to frequency modulate their output signals with the Doppler shifts of the two reflected signals, and moreover, the frequency modulations of the output signals of the two radar devices caused by the Doppler shift components due to body movement are adjusted to be equal in magnitude and out of phase. Meanwhile, the two radar devices will enter the mutual-injection locking state to output the signals having the same frequency modulation when the first reflected signal is received by the second antenna and then delivered to the second radar device and the second reflected signal is received by the first antenna and then delivered to the first radar device, wherein the frequency modulation of the output signals of the two radar devices is approximately the average of the frequency modulations of the output signals of two radar devices in the self-injection locking state. Because the frequency modulations of the output signals caused by the Doppler shift components due to body movement in the self-injection locking state are equal in magnitude and out of phase, they can be cancelled out in the mutual-injection locking state. However, because of the use of the two different gain antennas, the frequency modulations caused by the Doppler shift components due to vital signs have significantly different magnitude in the self-injection locking state and, therefore, they cannot be cancelled out in the mutual-injection locking state, so the vital signs of the subject can be obtained by frequency demodulating one of the output signals of the two radar devices.

[0009] In the drawings:

Fig. 1 is a schematic diagram illustrating a non-contact vital sign monitoring system in accordance with the first embodiment of the present invention.

Fig. 2 is a schematic diagram illustrating an up-down antenna setup of a non-contact vital sign monitoring system in accordance with the second embodiment of the present invention.

Fig. 3 is experimental results of monitoring a still subject using the non-contact vital sign monitoring system in accordance with the second embodiment of the present invention.

Fig. 4 is experimental results of monitoring a moving subject using the non-contact vital sign monitoring system in accordance with the second embodiment

of the present invention.

Fig. 5 is a schematic diagram illustrating a front-rear antenna setup of a non-contact vital sign monitoring system in accordance with the third embodiment of the present invention.

Fig. 6 is experimental results of monitoring a still subject using the non-contact vital sign monitoring system in accordance with the third embodiment of the present invention.

Fig. 7 is experimental results of monitoring a moving subject using the non-contact vital sign monitoring system in accordance with the third embodiment of the present invention.

Fig. 8 is a schematic diagram illustrating a circulator array of a non-contact vital sign monitoring system in accordance with the fourth embodiment of the present invention.

[0010] With reference to Fig. 1, a non-contact vital sign monitoring system 100 in accordance with a first embodiment of the present invention comprises a first radar device 110, a first antenna 120, a second radar device 130 and a second antenna 140.

[0011] With reference to Fig. 1, the first radar device 110 includes a first frequency demodulation and control unit 111, a first voltage-controlled oscillator (VCO) 112 and an amplitude and phase adjusting unit 113, wherein the first VCO 112 is electrically connected with the first frequency demodulation and control unit 111 and the amplitude and phase adjusting unit 113. The first frequency demodulation and control unit 111 is used for controlling the frequency of a first transmission signal E1 generated from the first VCO 112 and demodulating an output signal O1 from the first VCO 112, wherein the first transmission signal E1 is delivered to the amplitude and phase adjusting unit 113, and the amplitude and phase adjusting unit 113 is used for adjusting the amplitude and phase of the first transmission signal E1.

[0012] The first antenna 120 is electrically connected to the amplitude and phase adjusting unit 113, wherein the first transmission signal E1 adjusted in amplitude and phase is delivered to the first antenna 120, and the first antenna 120 is used for transmitting the first transmission signal E1 toward a side S of a biological subject B. The first antenna 120 has a first gain value, and the first gain value is 12 dBi in this embodiment.

[0013] The second antenna 130 includes a second frequency demodulation and control unit 131 and a second voltage-controlled oscillator (VCO) 132 electrically connected to the second frequency demodulation and control unit 131. The second frequency demodulation and control unit 131 is used for controlling the frequency of a second transmission signal E2 generated from the second VCO 132 and demodulating an output signal O2 from the second VCO 132, wherein the first transmission signal E1 and the second transmission signal E2 are controlled to have similar frequency by the first frequency demodulation and control unit 111 and the second fre-

quency demodulation and control unit 131, respectively, for ease of synchronizing the first VCO 112 and the second VCO 132 based on mutual injection locking.

[0014] The second antenna 140 is electrically connected to the second VCO 132, wherein the second transmission signal E2 is delivered to the second antenna 140, and the second antenna 140 is used for transmitting the second transmission signal E2 to a side S of the biological subject B, the first transmission signal E1 and the second transmission signal E2 are transmitted to the same side of the biological subject B. The second antenna 140 has a second gain value, wherein the first gain value is higher than the second gain value, and the second gain value is 6 dBi in this embodiment.

[0015] With reference to Fig. 1 again, the biological subject B respectively reflects a first reflected signal R1 and a second reflected signal R2 after the first transmission signal E1 and the second transmission signal E2 are transmitted to the biological subject B. The first antenna 120 and the second antenna 140 both receive the first reflected signal R1 and the second reflected signal R2, and the first reflected signal R1 and the second reflected signal R2 are delivered to the first radar device 110 and the second radar device 130 to make the first radar device 110 and the second radar device 130 operate in a self- and mutual-injection locking state.

[0016] The self-injection locking path of the first radar device 110: the first VCO 112→the amplitude and phase adjusting unit 113→the first antenna 120→the biological subject B→the first antenna 120→the amplitude and phase adjusting unit 113→the first VCO 112. The mutual-injection locking path of the first radar device 110: the second VCO 132→the second antenna 140→the biological subject B→the first antenna 120→the amplitude and phase adjusting unit 113→the first VCO 112. The self-injection locking path of the second radar device 130: the second VCO 132→the second antenna 140→the biological subject B→the second antenna 140→the second VCO 132. The mutual-injection locking path of the second radar device 130: the first VCO 112→the amplitude and phase adjusting unit 113→the first antenna 120→the biological subject B→the second antenna 140→the second VCO 132.

[0017] The first antenna 120 and the second antenna 140 in this embodiment transmit the first transmission signal E1 and the second transmission signal E2 to the biological subject B, respectively. The first antenna 120 receives the first reflected signal R1 from the biological subject B and delivers the first reflected signal R1 to the first VCO 112, and the second antenna 140 receives the second reflected signal R2 from the biological subject B and delivers the second reflected signal R2 to the second VCO 132, wherein the two VCOs 112 and 132 are in a self-injection locking state. The Doppler shifts of the reflected signals frequency modulate the output signals of the VCOs 112 and 132, and the frequency modulations of the output signals from the VCOs 112 and 132 caused by body movement are adjusted to be equal in magnitude

and out of phase by the amplitude and phase adjusting unit 113. Besides, the VCOs 112 and 132 are in a mutual-injection locking state and both output signals having the same frequency modulation when the first reflected signal R1 is received by the second antenna 140 and then delivered to the second VCO 132 and the second reflected signal R2 is received by the first antenna 120 and then delivered to the first VCO 112, wherein the frequency modulations of the output signals from the VCOs 112 and 132 in the self- and mutual-injection locking state is about the average of the frequency modulations of the output signals from the VCOs 112 and 132 in the self-injection locking state only. Owing to the frequency modulations of the output signals caused by body movement are equal in magnitude and out of phase when the VCOs 112 and 132 are in the self-injection locking state only, they can be cancelled out in the self- and mutual-injection locking state. And owing to the frequency modulations of the output signals caused by vital signs from the VCOs 112 and 132 are significantly different due to the different gains of the antennas 120 and 140, they cannot be cancelled out in the self- and mutual-injection locking state. Therefore, the vital signs of the biological subject B can be obtained by frequency modulating one of the output signals O1 and O2 from the VCOs 112 and 132.

[0018] In addition, the antenna beams of the first antenna 120 and the second antenna 140 both are directed toward the same area on the side S of the biological subject B (e.g. sternum of human chest), but the gains of the first antenna 120 and the second antenna 140 are different. The Doppler shift components of the first reflected signal R1 and the second reflected signal R2 caused by body movement can be equal in magnitude and out of phase by adjusting the location and included angle of the first antenna 120 relative to the second antenna 140 and adjusting the amplitude and phase of the first reflected signal R1 by the amplitude and phase adjusting unit 113, so the Doppler shift components caused by body movement can be cancelled out when the first VCO 112 and the second VCO 132 are in the self- and mutual-injection locking state. And the Doppler shift components of the first reflected signal R1 and the second reflected signal R2 caused by vital signs are significantly different and cannot be cancelled out, so the vital signs can be preserved and monitored in real time.

[0019] Preferably, the first antenna 120 and the second antenna 140 are setup relative to the biological subject B in particular way to significantly enhance the difference between the Doppler shift components of the first reflected signal R1 and the second reflected signal R2 caused by vital signs for increasing the accuracy of vital sign monitoring.

[0020] With reference to Fig. 2, the first antenna 120 and the second antenna 140 in a second embodiment of the present invention are setup in an up-down configuration, wherein the first antenna 120 has a first central axis 121 and the second antenna 140 has a second central axis 141, and the first central axis 121 and the second

central axis 141 both are directed to an area A on the side S of the biological subject B. The second central axis 141 is parallel to floor substantially, and the first central axis 121 is tilted relative to floor to form an included angle θ of less than 90 degrees between the first central axis 121 and the second central axis 141. In this embodiment, the included angle θ is 55 degrees when the system operates in the 2.4-GHz industrial, scientific and medical band.

[0021] Owing to the gain of the first antenna 120 is higher than that of the second antenna 140 in this embodiment, the magnitude of the first reflected signal R1 received by the first antenna 120 will be higher than that of the second reflected signal R2 received by the second antenna 140 when the first antenna 120 and the second antenna 140 are setup in parallel without tilt, so the Doppler component of the first reflected signal R1 caused by body movement will be larger than that of the second reflected signal R2 caused by body movement. Therefore, the first antenna 120 is tilted an angle θ with respect to the second antenna 140 to decrease the Doppler component of the first reflected signal R1 caused by body movement for getting close in magnitude to the Doppler component of the second reflected signal R2 caused by body movement. Moreover, the Doppler component of the first reflected signal R1 caused by vital signs is decreased more significantly because of the tilted angle θ of the first antenna 120, so it will be lower in magnitude than the Doppler component of the second reflected signal R2 caused by vital signs. The first radar device 110 and the second radar device 130 will operate in the self- and mutual-injection locking state to cancel out the Doppler shift components caused by body movement when the first reflected signal R1 and the second reflected signal R2 are delivered to the first radar device 110 and the second radar device 130, and the vital signs of the biological subject B can be preserved because the Doppler shift components caused by vital signs cannot be cancelled out.

[0022] With reference to Fig. 3 which shows experimental results of monitoring a human sitting still in front of the non-contact vital sign monitoring system 100 in accordance with the second embodiment at a distance of 70 cm, wherein the frequencies of respiration and heartbeat are clearly identified in Fig. 3, so it indicates that using the system of the second embodiment can detect the vital signs of the biological subject B accurately when the human body is still. With reference to Fig. 4 which shows experimental results of monitoring a human sitting in front of the non-contact vital sign monitoring system 100 at a distance of 70 cm in accordance with the second embodiment, and moving his upper body randomly within a target range from -3 to 3 cm, wherein the frequencies of respiration and heartbeat are also clearly identified in Fig. 4, so it indicates that using the system of the second embodiment can detect the vital signs of the biological subject B accurately when the human body is moving.

[0023] With reference to Fig. 5, the first antenna 120 and the second antenna 140 in a third embodiment of the present invention are setup in a front-rear configuration, wherein the first antenna 120 has a first central axis 121 and the second antenna 140 has a second central axis 141, and the first central axis 121 and the second central axis 141 both are directed to an area A on the side S of the biological subject B. There is a distance D between the first antenna 120 and the second antenna 140, and the second antenna 140 is located between the first antenna 120 and the biological subject B. In this embodiment, the distance D is 20 cm when the system operates in the 2.4 GHz industrial, scientific and medical band.

[0024] In the setup of the first antenna 120 and the second antenna 140 of the third embodiment, the first transmission signal E1 transmitted from the first antenna 120 is partially blocked by the metal plate of the second antenna 140 to decrease the Doppler component of the first reflected signal R1 caused by body movement for getting close in magnitude to the Doppler component of the second reflected signal R2 caused by body movement. Moreover, the Doppler component of the first reflected signal R1 caused by vital signs is decreased more significantly because of the blocking effect from the second antenna 140, so it will be lower in magnitude than the Doppler component of the second reflected signal R2 caused by vital signs. The first radar device 110 and the second radar device 130 will operate in the self- and mutual-injection locking state to cancel out the Doppler shift components caused by body movement when the first reflected signal R1 and the second reflected signal R2 are delivered to the first radar device 110 and the second radar device 130, and the vital signs of the biological subject B can be preserved because the Doppler shift components caused by vital signs cannot be cancelled out.

[0025] With reference to Fig. 6 which shows experimental results of monitoring a human sitting still in front of the non-contact vital sign monitoring system 100 in accordance with the third embodiment at a distance of 70 cm, wherein the frequencies of respiration and heartbeat are clearly identified in Fig. 6, so it indicates that using the system of the third embodiment can detect the vital signs of the biological subject B accurately when the human body is still. With reference to Fig. 7 which shows experimental results of monitoring a human sitting in front of the non-contact vital sign monitoring system 100 at a distance of 70 cm in accordance with the third embodiment, and moving his upper body randomly within a target range from -3 to 3 cm, wherein the frequencies of respiration and heartbeat are also clearly identified in Fig. 7, so it indicates that using the system of the third embodiment can detect the vital signs of the biological subject B accurately when the human body is moving.

[0026] With reference to Fig. 8, it is a schematic diagram showing the system of fourth embodiment. In the fourth embodiment, the first radar device 110 and the

second radar device 130 are connected with each other using a circulator array 150 to operate in the self- and mutual-injection locking state with improved detection performance.

[0027] The circulator array 150 is electrically connected with the first radar device 110 and the second radar device 130, wherein the output signal from the first radar device 110 is delivered to the first antenna 120 via the circulator array 150, and the output signal from the second radar device 130 is delivered to the second antenna 140 via the circulator array 150.

[0028] With reference to Fig. 8, the circulator array 150 includes a first circulator 151, a second circulator 152, a third circulator 153, a fourth circulator 154 and a tunable phase shifter 155. The first circulator 151 is electrically connected with the first radar device 110, the second circulator 152 and the third circulator 153. The second circulator 152 is electrically connected with the second radar device 130 and the fourth circulator 154. The third circulator 153 is electrically connected with the tunable phase shifter 155 and the second antenna 140. The fourth circulator 154 is electrically connected with the tunable phase shifter 155 and the first antenna 120. The tunable phase shifter 155 is electrically connected with the third circulator 153 and the fourth circulator 154. In more detail, a first port 151a of the first circulator 151 is electrically connected to the first radar device 110, a second port 151b of the first circulator 151 is electrically connected to a first port 152a of the second circulator 152, and a third port 151c of the first circulator 151 is electrically connected to a first port 153a of the third circulator 153. A third port 152c of the second circulator 152 is electrically connected to the second radar device 130, and a second port 152b of the second circulator 152 is electrically connected to a second port 154b of the fourth circulator 154. A second port 153b of the third circulator 153 is electrically connected to the second antenna 140, and a third port 153c of the third circulator 153 is electrically connected to a first port 155a of the tunable phase shifter 155. A second port 155b of the tunable phase shifter 155 is electrically connected to a first port 154a of the fourth circulator 154, and a third port 154c of the fourth circulator 154 is electrically connected to the first antenna 120.

[0029] In this embodiment, the output signal from the first radar device 110 is input to the first port 151a of the first circulator 151 and output from the second port 151b, then input to the first port 152a of the second circulator 152 and output from the second port 152b, then input to the second port 154b of the fourth circulator 154 and output from the third port 154c, and then delivered to the first antenna 120 for transmission to the subject, wherein the first reflected signal R1 from the subject is received by the first antenna 120 and the second antenna 140. The first reflected signal R1 received by the first antenna 120 is input to the third port 154c of the fourth circulator 154 and output from the first port 154a, then input to the second port 155b of the tunable phase shifter 155 and

output from the first port 155a, then input to the third port 153c of the third circulator 153 and output from the first port 153a, then input to third port 151c of the first circulator 151 and output from the first port 151a, and finally delivered to the first radar device 110, so the first radar device 110 is self-injection locked by the first reflected signal R1. The first reflected signal R1 received by the second antenna 140 is input to the second port 153b of the third circulator 153 and output from the third port 153c, then input to the first port 155a of the tunable phase shifter 155 and output from the second port 155b, then input to the first port 154a of the fourth circulator 154 and output from the second port 154b, then input to the second port 152b of the second circulator 152 and output from the third port 152c, and finally delivered to the second radar device 130, so the second radar device 130 is mutual-injection locked by the first reflected signal R1.

[0030] In contrast, the output signal from the second radar device 130 is input to the third port 152c of the second circulator 152 and output from the first port 152a, then input to the second port 151b of the first circulator 151 and output from the third port 151c, then input to the first port 153a of the third circulator 153 and output from the second port 153b, and then delivered to the second antenna 140 for transmission to the subject, wherein the second reflected signal R2 from the subject is received by the first antenna 120 and the second antenna 140. The second reflected signal R2 received by the second antenna 140 is input to the second port 153b of the third circulator 153 and output from the third port 153c, then input to the first port 155a of the tunable phase shifter 155 and output from the second port 155b, then input to the first port 154a of the fourth circulator 154 and output from the second port 154b, then input to the second port 152b of the second circulator 152 and output from the third port 152c, and finally delivered to the second radar device 130, so the second radar 130 is self-injection locked by the second reflected signal R2. The second reflected signal R2 received by the first antenna 120 is input to the third port 154c of the fourth circulator 154 and output from the first port 154a, then input to the second port 155b of the tunable phase shifter 155 and output from the first port 155a, then input to the third port 153c of the third circulator 153 and output from the first port 153a, then input to the third port 151c of the first circulator 151 and output from the first port 151a, and finally delivered to the first radar device 110, so the first radar device 110 is mutual-injection locked by the second reflected signal R2.

[0031] According to the aforementioned, the first radar device 110 and the second radar device 130 both can receive the first reflected signal R1 and the second reflected signal R2 via the circulator array 150 for operation in self- and mutual-injection locking state. The first reflected signal R1 and the second reflected signal R2 are both delivered to the first radar device 110 and the second radar device 130 through the tunable phase shifter 155, so adjusting the phase shift of the tunable phase shifter

155 can improve the detection performance of the first radar device 110 and the second radar device 130. The phase shift is adjusted between 0 and 90 degrees, wherein the adjusted phase shift is 13 degrees when the system is operated in the 2.4 GHz industrial, scientific and medical band.

[0032] The invention is defined by appended claims 1-9.

Claims

1. Non-contact vital sign monitoring system (100) comprising:

a first radar device (110) configured to generate a first transmission signal (E1);
a first antenna (120) configured to transmit the first transmission signal (E1) to a subject (B);
a second radar device (130) configured to generate a second transmission signal (E2); and
a second antenna (140) configured to transmit the second transmission signal (E2) to said subject (B),

characterized in that

the first antenna (120) has a gain value which is higher than the gain value of the second antenna (140),

the first antenna (120) and the second antenna (140) are arranged to transmit said first and second transmission signals (E1, E2) to the same side of the subject (B) and configured to receive first and second reflected signals (R1, R2) and deliver same to the first radar device (110) and the second radar device (130), said first reflected signal (R1) representing reflection of the first transmission signal (E1) from the subject (B) and said second transmission signal (E2) representing reflection of the second transmitted signal (E2) from the subject (B), and

wherein the first radar device (110) and the second radar device (130) are configured to operate in a self- and mutual-injection locking state to thereby cancel out body movement and obtain vital signs of the subject (B).

2. Non-contact vital sign monitoring system according to claim 1, **characterized in that** the first radar device (110) includes a first frequency demodulation and control unit (111) and a first voltage-controlled oscillator (VCO) (112), and the second radar device (130) includes a second frequency demodulation and control unit (131) and a second voltage-controlled oscillator (VCO) (132), and wherein the first VCO (112) is electrically connected to the first frequency demodulation and control unit (111) for outputting the first transmission signal (E1), and the second VCO (132) is electrically connected to the second

frequency demodulation and control unit (131) for outputting the second transmission signal (E2).

3. Non-contact vital sign monitoring system according to claim 2, **characterized in that** the first radar device (110) further includes an amplitude and phase adjusting unit (113) which is electrically connected with the first VCO (112) and the first antenna (120), and wherein the amplitude and phase adjusting unit (113) is used for adjusting amplitudes and phases of the first transmission signal (E1) and the first reflected signal (R1).
4. Non-contact vital sign monitoring system according to one of claims 1 to 3, **characterized in that** antenna beams of the first antenna (120) and the second antenna (140) are both adapted to be directed toward a same area on the same side (S) of the subject (B).
5. Non-contact vital sign monitoring system according to claim 4, **characterized in that** the first antenna (120) has a first central axis (121) and the second antenna (140) has a second central axis (141), and the first central axis (121) and the second central axis (141) are both adapted to be directed to the same area on the same side (S) of the subject (B), and wherein the second central axis (141) is arranged to be parallel to a floor substantially and the first central axis (121) is arranged to be tilted relative to the floor to form an included angle (θ) of less than 90 degrees between the first central axis (121) and the second central axis (141).
6. Non-contact vital sign monitoring system according to claim 4, **characterized in that** the first antenna (120) has a first central axis (121) and the second antenna (140) has a second central axis (141), and the first central axis (121) and the second central axis (141) are both adapted to be directed to the same area on the same side (S) of the subject (B), and wherein there is a distance (D) between the first antenna (120) and the second antenna (140), and the second antenna (140) is arranged to be located between the first antenna (120) and the subject (B) to block a part of the antenna beam of the first antenna (120).
7. Non-contact vital sign monitoring system according to one of claims 1 to 6, further comprising a circulator array (150) electrically connected with the first radar device (110) and the second radar device (130), wherein the first transmission signal (E1) from the first radar device (110) is transmitted to the first antenna (120) via the circulator array (150), and the second transmission signal (E2) from the second radar device (130) is transmitted to the second antenna (140) via the circulator array (150).

8. Non-contact vital sign monitoring system according to claim 7, **characterized in that** the circulator array (150) includes a first circulator (151), a second circulator (152), a third circulator (153), a fourth circulator (154) and a tunable phase shifter (155), and wherein the first circulator (151) is electrically connected with the first radar device (110), the second circulator (152) and the third circulator (153), the second circulator (152) is electrically connected with the second radar device (130) and the fourth circulator (154), the third circulator (153) is electrically connected with the tunable phase shifter (155) and the second antenna (140), the fourth circulator (154) is electrically connected with the tunable phase shifter (155) and the first antenna (120), and the tunable phase shifter (155) is electrically connected with the third circulator (153) and the fourth circulator (154).
9. Non-contact vital sign monitoring system according to claims 8, **characterized in that** a first port (151a) of the first circulator (151) is electrically connected to the first radar device (110), a second port (151b) of the first circulator (151) is electrically connected to a first port (152a) of the second circulator (152), a third port (151c) of the first circulator (151) is electrically connected to a first port (153a) of the third circulator (153), a third port (152c) of the second circulator (152) is electrically connected to the second radar device (130), a second port (152b) of the second circulator (152) is electrically connected to a second port (154b) of the fourth circulator (154), a second port (153b) of the third circulator (153) is electrically connected to the second antenna (140), a third port (153c) of the third circulator (153) is electrically connected to a first port (155a) of the tunable phase shifter (155), a third port (154c) of the fourth circulator (154) is electrically connected to the first antenna (120), and a first port (154a) of the fourth circulator (154) is electrically connected to a second port (155b) of the tunable phase shifter (155).

Patentansprüche

1. System (100) zur kontaktlosen Überwachung von Vitalparametern, umfassend:
 - eine erste Radarvorrichtung (110), die dazu konfiguriert ist, ein erstes Sendesignal (E1) zu erzeugen;
 - eine erste Antenne (120), die dazu konfiguriert ist, das erste Sendesignal (E1) an einen Probanden (B) zu senden;
 - eine zweite Radarvorrichtung (130), die dazu konfiguriert ist, ein zweites Sendesignal (E2) zu erzeugen; und
 - eine zweite Antenne (140), die dazu konfiguriert ist, das zweite Sendesignal (E2) an den Probanden

- den (B) zu senden,
dadurch gekennzeichnet, dass
 die erste Antenne (120) einen Verstärkungswert aufweist, der höher als der Verstärkungswert der zweiten Antenne (140) ist,
 die erste Antenne (120) und die zweite Antenne (140) dazu eingerichtet sind, das erste und zweite Sendesignal (E1, E2) zur selben Seite des Probanden (B) zu senden, und dazu konfiguriert sind, erste und zweite reflektierte Signale (R1, R2) zu empfangen und dieselben an die erste Radarvorrichtung (110) und die zweite Radarvorrichtung (130) zu leiten, wobei das erste reflektierte Signal (R1) die Reflexion des ersten Sendesignals (E1) von dem Probanden (B) repräsentiert und das zweite Sendesignal (E2) die Reflexion des zweiten gesendeten Signals (E2) von dem Probanden (B) repräsentiert, und wobei die erste Radarvorrichtung (110) und die zweite Radarvorrichtung (130) dazu konfiguriert sind, in einem eigenen und wechselseitigen Injektionssperrenzustand zu arbeiten, um dadurch Körperbewegungen und Vitalparameter des Probanden (B) zu erfassen.
2. System zur kontaktlosen Überwachung von Vitalparametern nach Anspruch 1, **dadurch gekennzeichnet, dass** die erste Radarvorrichtung (110) eine erste Frequenzdemodulations- und Steuereinheit (111) und einen ersten spannungsgesteuerten Oszillator (VCO) (112) beinhaltet, und die zweite Radarvorrichtung (130) eine zweite Frequenzdemodulations- und Steuereinheit (130) und einen zweiten spannungsgesteuerten Oszillator (VCO) (132) beinhaltet, und wobei der erste VCO (112) elektrisch mit der ersten Frequenzdemodulations- und Steuereinheit (111) zum Ausgeben des ersten Sendesignals (E1) verbunden ist, und der zweite VCO (132) elektrisch mit der zweiten Frequenzdemodulations- und Steuereinheit (131) zum Ausgeben des zweiten Sendesignals (E2) verbunden ist.
3. System zur kontaktlosen Überwachung von Vitalparametern nach Anspruch 2, **dadurch gekennzeichnet, dass** die erste Radarvorrichtung (110) des Weiteren eine Amplituden- und Phaseneinstellungseinheit (113) beinhaltet, die elektrisch mit dem ersten VCO (112) und der ersten Antenne (120) verbunden ist, und wobei die Amplituden- und Phaseneinstellungseinheit (113) zum Einstellen von Amplituden und Phasen des ersten Sendesignals (E1) und des ersten reflektierten Signals (R1) dient.
4. System zur kontaktlosen Überwachung von Vitalparametern nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** Antennenstrahlen der ersten Antenne (120) und der zweiten Antenne (140) beide dazu eingerichtet sind, in Richtung eines
- selben Bereiches auf derselben Seite (S) des Probanden (B) gerichtet zu werden.
5. System zur kontaktlosen Überwachung von Vitalparametern nach Anspruch 4, **dadurch gekennzeichnet, dass** die erste Antenne (120) eine erste Mittelachse (121) aufweist und die zweite Antenne (140) eine zweite Mittelachse (141) aufweist, und die erste Mittelachse (121) und die zweite Mittelachse (141) beide dazu eingerichtet sind, auf denselben Bereich auf derselben Seite (S) des Probanden (B) gerichtet zu werden, und wobei die zweite Mittelachse (141) dazu eingerichtet ist, im Wesentlichen parallel zu einem Boden zu verlaufen, und die erste Mittelachse (121) dazu eingerichtet ist, relativ zu dem Boden geneigt zu werden, so dass ein eingeschlossener Winkel (θ) von weniger als 90 Grad zwischen der ersten Mittelachse (121) und der zweiten Mittelachse (141) gebildet wird.
6. System zur kontaktlosen Überwachung von Vitalparametern nach Anspruch 4, **dadurch gekennzeichnet, dass** die erste Antenne (120) eine erste Mittelachse (121) aufweist und die zweite Antenne (140) eine zweite Mittelachse (141) aufweist, und die erste Mittelachse (121) und die zweite Mittelachse (141) beide dazu eingerichtet sind, auf denselben Bereich auf derselben Seite (S) des Probanden (B) gerichtet zu werden, und wobei eine Distanz (D) zwischen der ersten Antenne (120) und der zweiten Antenne (140) besteht, und die zweite Antenne (140) dazu eingerichtet ist, zwischen der ersten Antenne (120) und dem Probanden (B) angeordnet zu werden, um einen Teil des Antennenstrahls der ersten Antenne (120) zu blockieren.
7. System zur kontaktlosen Überwachung von Vitalparametern nach einem der Ansprüche 1 bis 6, des Weiteren umfassend eine Zirkulatoranordnung (150), die elektrisch mit der ersten Radarvorrichtung (110) und der zweiten Radarvorrichtung (130) verbunden ist, wobei das erste Sendesignal (E1) von der ersten Radarvorrichtung (110) über die Zirkulatoranordnung (150) an die erste Antenne (120) gesendet wird, und das zweite Sendesignal (E2) von der zweiten Radarvorrichtung (130) über die Zirkulatoranordnung (150) an die zweite Antenne (140) gesendet wird.
8. System zur kontaktlosen Überwachung von Vitalparametern nach Anspruch 7, **dadurch gekennzeichnet, dass** die Zirkulatoranordnung (150) einen ersten Zirkulator (151), einen zweiten Zirkulator (152), einen dritten Zirkulator (153), einen vierten Zirkulator (154) und einen abstimmbaren Phasenschieber (155) beinhaltet, und wobei der erste Zirkulator (151) elektrisch mit der ersten Radarvorrichtung (110), dem zweiten Zirkulator (152) und dem dritten Zirkulator (153) verbunden ist, und der zweite Zirkulator (152) elektrisch mit der zweiten Radarvorrichtung (130), dem dritten Zirkulator (153) und dem vierten Zirkulator (154) verbunden ist, und der dritte Zirkulator (153) elektrisch mit dem vierten Zirkulator (154) und dem Phasenschieber (155) verbunden ist, und der Phasenschieber (155) elektrisch mit dem ersten Zirkulator (151) und dem zweiten Zirkulator (152) verbunden ist.

lator (153) verbunden ist, der zweite Zirkulator (152) elektrisch mit der zweiten Radarvorrichtung (130) und dem vierten Zirkulator (154) verbunden ist, der dritte Zirkulator (153) elektrisch mit dem abstimm-
baren Phasenschieber (155) und der zweiten Antenne (140) verbunden ist, der vierte Zirkulator (154) elektrisch mit dem abstimm-
baren Phasenschieber (155) und der ersten Antenne (120) verbunden ist, und der abstimm-
bare Phasenschieber (155) elektrisch mit dem dritten Zirkulator (153) und dem vier-
ten Zirkulator (154) verbunden ist.

9. System zur kontaktlosen Überwachung von Vitalparametern nach Anspruch 8, **dadurch gekennzeichnet, dass** ein erster Anschluss (151a) des ersten Zirkulators (151) elektrisch mit der ersten Radarvorrichtung (110) verbunden ist, ein zweiter Anschluss (151b) des ersten Zirkulators (151) elektrisch mit einem ersten ersten Anschluss (152a) des zweiten Zirkulators (152) verbunden ist, ein dritter Anschluss (151c) des ersten Zirkulators (151) elektrisch mit einem ersten Anschluss (153a) des dritten Zirkulators (153) verbunden ist, ein dritter Anschluss (152c) des zweiten Zirkulators (152) elektrisch mit der zweiten Radarvorrichtung (130) verbunden ist, ein zweiter Anschluss (152b) des zweiten Zirkulators (152) elektrisch mit einem zweiten Anschluss (154b) des vierten Zirkulators (154) verbunden ist, ein zweiter Anschluss (153b) des dritten Zirkulators (153) elektrisch mit der zweiten Antenne (140) verbunden ist, ein dritter Anschluss (153c) des dritten Zirkulators (153) elektrisch mit einem ersten Anschluss (155a) des abstimmbaren Phasenschiebers (155) verbunden ist, ein dritter Anschluss (154c) des vierten Zirkulators (154) elektrisch mit der ersten Antenne (120) verbunden ist, und ein vierter Anschluss (154a) des vierten Zirkulators (154) elektrisch mit einem zweiten Anschluss (155b) des abstimmbaren Phasenschiebers (155) verbunden ist.

Revendications

1. Système de surveillance de signe vital sans contact (100) comprenant :
- un premier dispositif de radar (110) configuré pour générer un premier signal de transmission (E1) ;
 - une première antenne (120) configurée pour transmettre le premier signal de transmission (E1) à un sujet (B) ;
 - un second dispositif de radar (130) configuré pour générer un second signal de transmission (E2) et
 - une seconde antenne (140) configurée pour transmettre le second signal de transmission (E2) audit sujet (B),

caractérisé en ce que

la première antenne (120) a une valeur de gain qui est supérieure à la valeur de gain de la seconde antenne (140),
la première antenne (120) et la seconde antenne (140) sont placées pour transmettre ledit premier et ledit second signal de transmission (E1, E2) au même côté du sujet (B) et configurées pour recevoir un premier et un second signal réfléchi (R1, R2) et délivrer ceux-ci au premier dispositif de radar (110) et au second dispositif de radar (130), ledit premier signal réfléchi (R1) représentant la réflexion du premier signal de transmission (E1) du sujet (B) et ledit second signal de transmission (E2) représentant la réflexion du second signal transmis (E2) du sujet (B) et
le premier dispositif de radar (110) et le second dispositif de radar (130) étant configurés pour fonctionner dans un état de verrouillage automatique et mutuel pour ainsi neutraliser le mouvement du corps et obtenir des signaux vitaux du sujet (B).

2. Système de surveillance de signe vital sans contact selon la revendication 1, **caractérisé en ce que** le premier dispositif de radar (110) comprend une première unité de démodulation de fréquence et de contrôle (111) et un premier oscillateur commandé en tension (VCO) (112) et le second dispositif de radar (130) comprend une seconde unité de démodulation de fréquence et de contrôle (131) et un second oscillateur commandé en tension (VCO) (132) et le premier VCO (112) étant relié électriquement à la première unité de démodulation de fréquence et de contrôle (111) pour sortir le premier signal de transmission (E1) et le second VCO (132) étant relié électriquement à la seconde unité de démodulation de fréquence et de contrôle (131) pour sortir le second signal de transmission (E2).
3. Système de surveillance de signe vital sans contact selon la revendication 2, **caractérisé en ce que** le premier dispositif de radar (110) comprend de plus une unité d'ajustement d'amplitude et de phase (113) qui est reliée électriquement au premier VCO (112) et à la première antenne (120) et l'unité d'ajustement d'amplitude et de phase (113) étant utilisée pour ajuster les amplitudes et les phases du premier signal de transmission (E1) et du premier signal réfléchi (R1).
4. Système de surveillance de signe vital sans contact selon l'une des revendications 1 à 3, **caractérisé en ce que** les faisceaux d'antenne de la première antenne (120) et de la seconde antenne (140) sont tous les deux adaptés à être dirigés vers une même zone sur le même côté (S) du sujet (B).

5. Système de surveillance de signe vital sans contact selon la revendication 4, **caractérisé en ce que** la première antenne (120) a un premier axe central (121) et la seconde antenne (140) a un second axe central (141) et le premier axe central (121) et le second axe central (141) sont tous les deux adaptés à être dirigés vers la même zone sur le même côté (S) du sujet (B) et le second axe central (141) étant placé pour être parallèle substantiellement à un sol et le premier axe central (121) étant placé pour être basculé par rapport au sol pour former un angle inclus (θ) inférieur à 90 degrés entre le premier axe central (121) et le second axe central (141).
6. Système de surveillance de signe vital sans contact selon la revendication 4, **caractérisé en ce que** la première antenne (120) a un premier axe central (121) et la seconde antenne (140) a un second axe central (141) et le premier axe central (121) et le second axe central (141) sont tous les deux adaptés à être dirigés vers la même zone sur le même côté (S) du sujet (B) et cependant qu'il y a une distance (D) entre la première antenne (120) et le sujet (B) pour bloquer une part du faisceau d'antenne de la première antenne (120).
7. Système de surveillance de signe vital sans contact selon l'une des revendications 1 à 6 comprenant de plus un réseau de circulateurs (150) relié électriquement au premier dispositif de radar (110) et au second dispositif de radar (130), le premier signal de transmission (E1) du premier dispositif de radar (110) étant transmis à la première antenne (120) par le réseau de circulateurs (150) et le second signal de transmission (E2) du second dispositif de radar (130) étant transmis à la seconde antenne (140) par le réseau de circulateurs (150).
8. Système de surveillance de signe vital sans contact selon la revendication 7, **caractérisé en ce que** le réseau de circulateurs (150) comprend un premier circulateur (151), un second circulateur (152), un troisième circulateur (153), un quatrième circulateur (154) et un déphaseur accordable (155), le premier circulateur (151) étant relié électriquement au premier dispositif de radar (110), au second circulateur (152) et au troisième circulateur (153), le second circulateur (152) étant relié électriquement au second dispositif de radar (130) et au quatrième circulateur (154), le troisième circulateur (153) étant relié électriquement au déphaseur accordable (155) et à la seconde antenne (140), le quatrième circulateur (154) étant relié électriquement au déphaseur accordable (155) et à la première antenne (120) et le déphaseur accordable (155) étant relié électriquement au troisième circulateur (153) et au quatrième circulateur (154).
9. Système de surveillance de signe vital sans contact selon la revendication 8, **caractérisé en ce qu'un** premier port (151a) du premier circulateur (151) est relié électriquement au premier dispositif de radar (110), un second port (151b) du premier circulateur (151) est relié électriquement à un premier port (152a) du second circulateur (152), un troisième port (151c) du premier circulateur (151) est relié électriquement à un premier port (153a) du troisième circulateur (153), un troisième port (152) du second circulateur (152) est relié électriquement au second dispositif de radar (130), un second port (152b) du second circulateur (152) est relié électriquement à un second port (154b) du quatrième circulateur (154), un second port (153b) du troisième circulateur (153) est relié électriquement à la seconde antenne (140), un troisième port (153c) du troisième circulateur (153) est relié électriquement à un premier port (155a) du déphaseur accordable (155), un troisième port (154c) du quatrième circulateur (154) est relié électriquement à la première antenne (120) et un premier port (154a) du quatrième circulateur (154) est relié électriquement à un second port (155b) du déphaseur accordable (155).

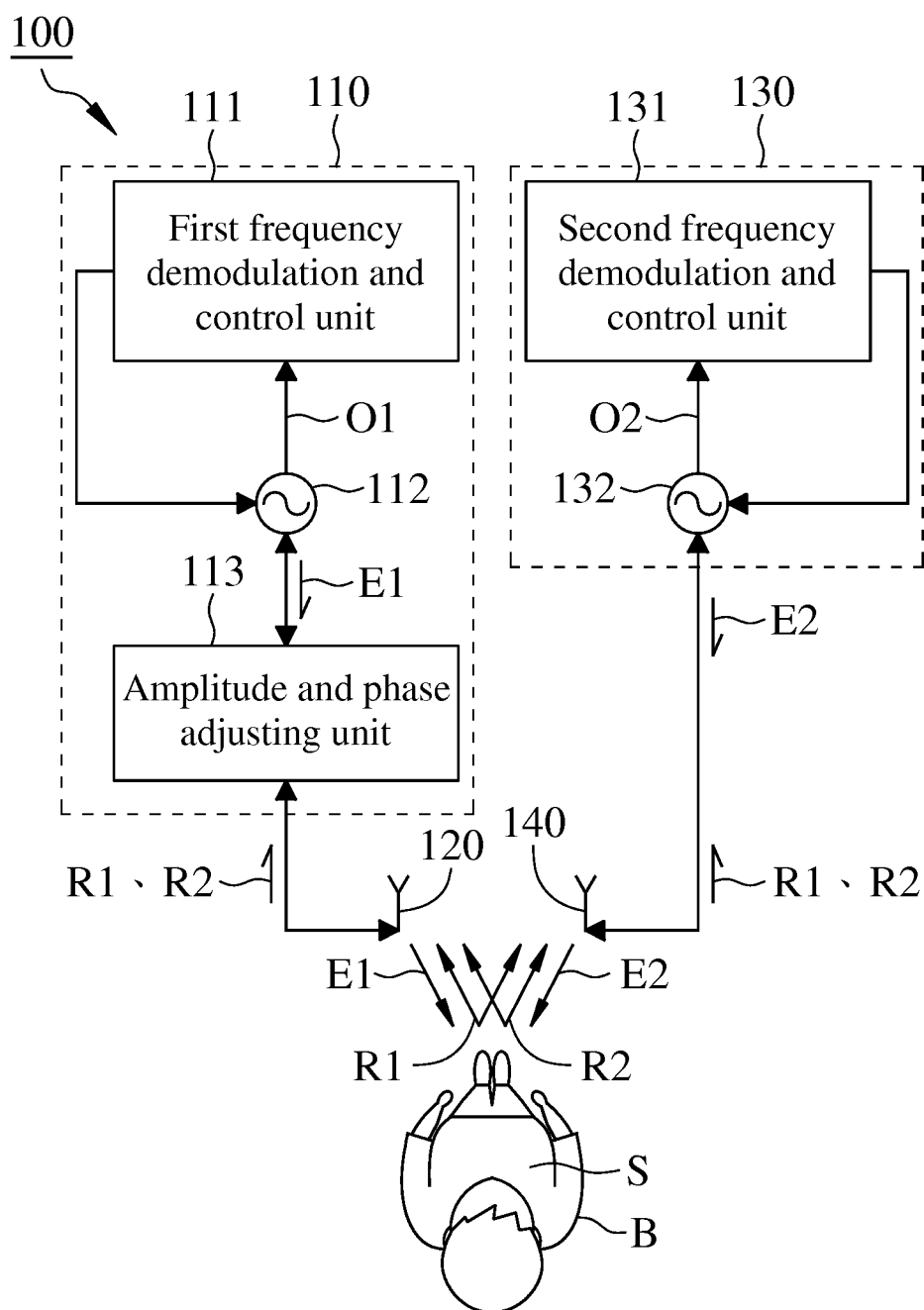


FIG. 1

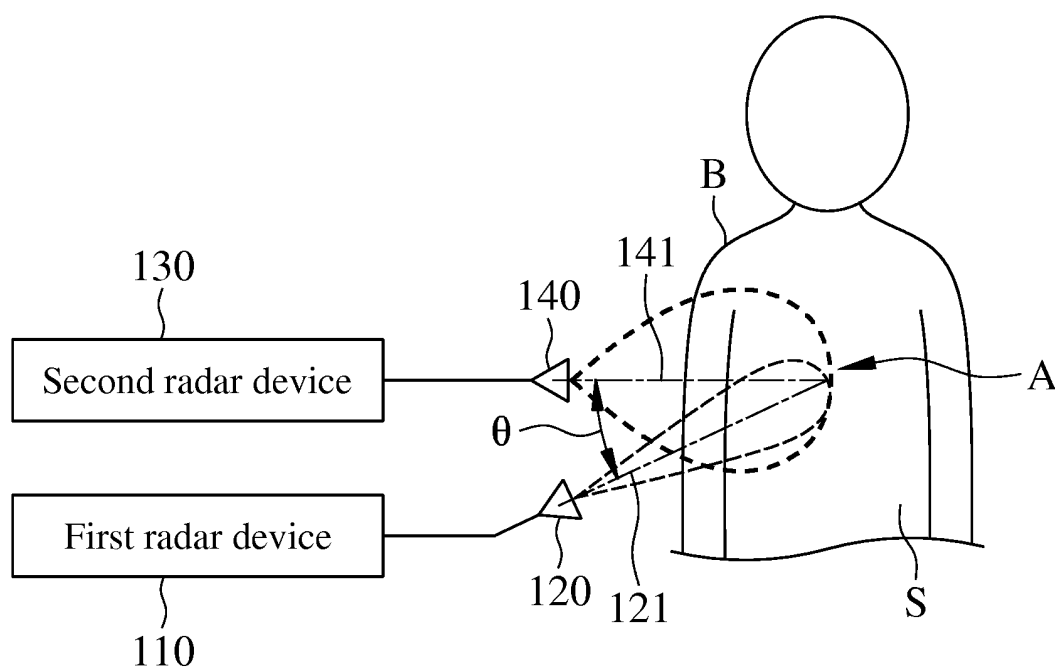


FIG. 2

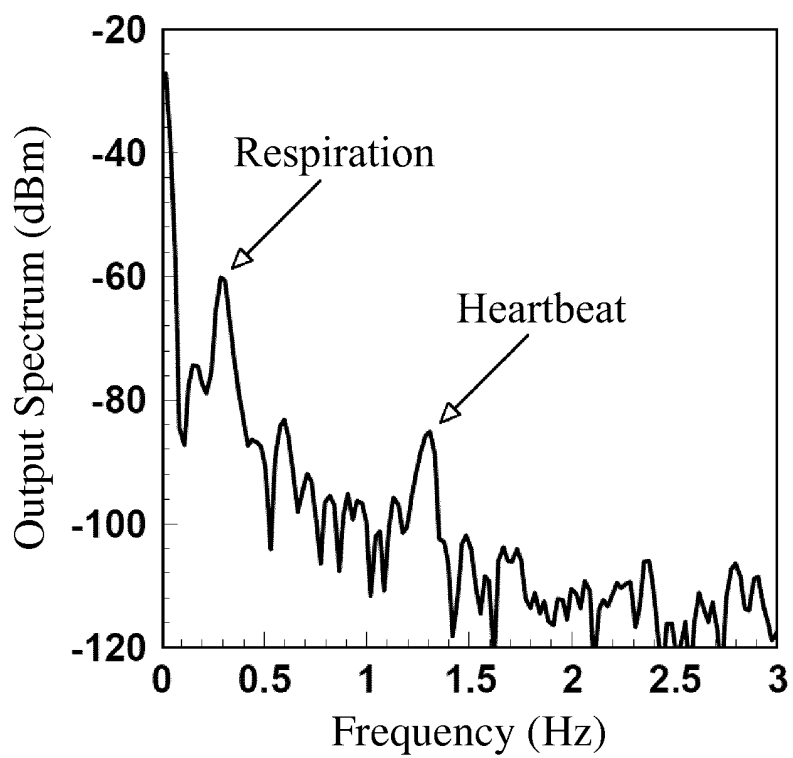


FIG. 3

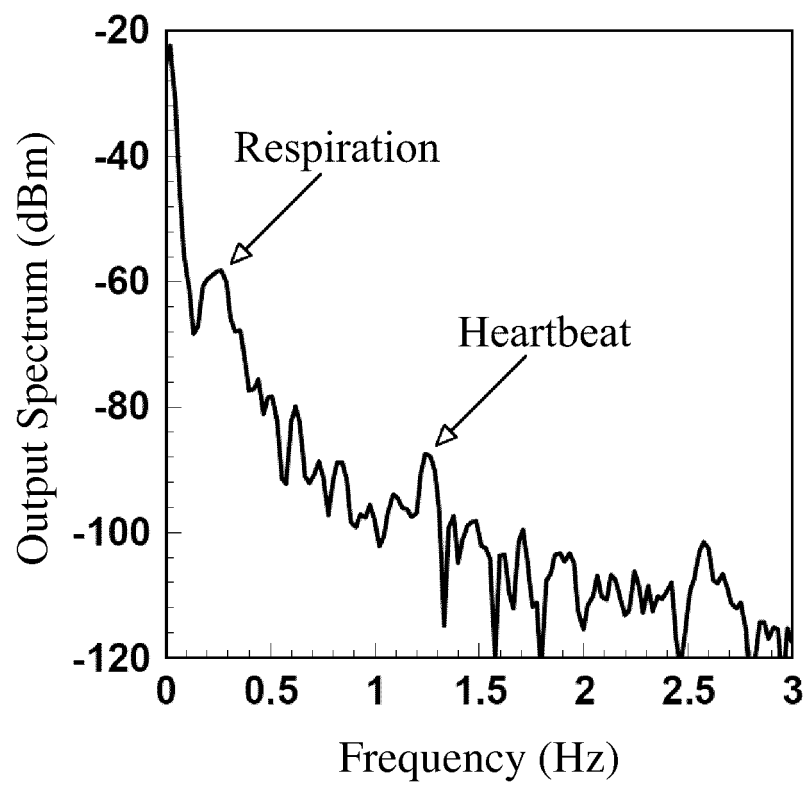


FIG. 4

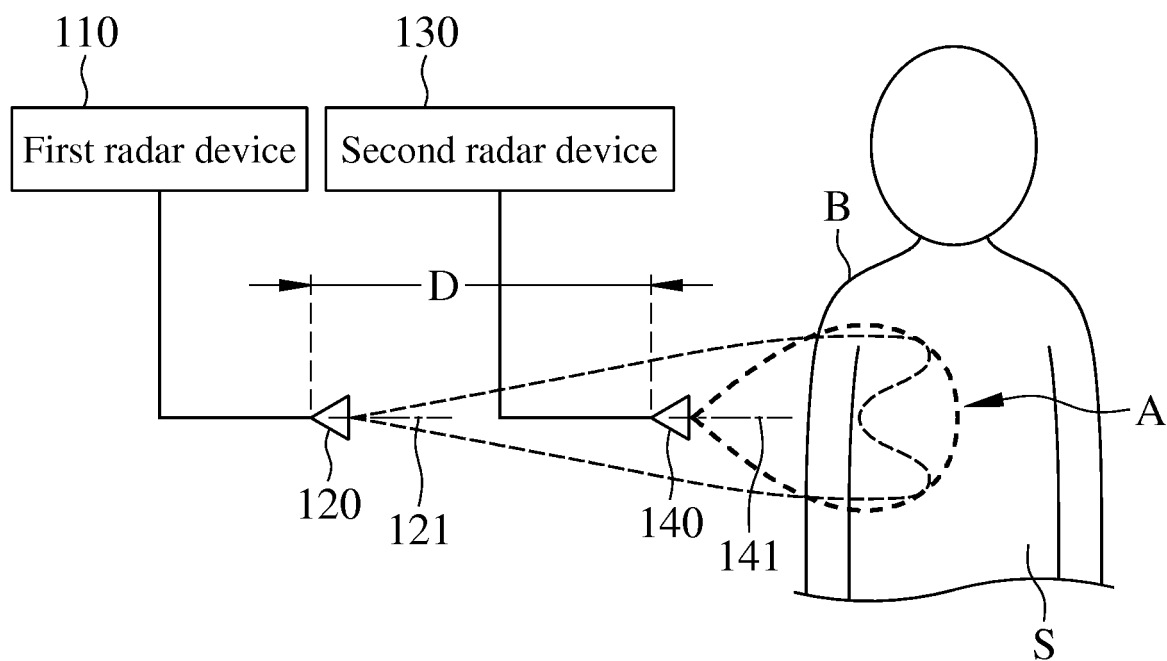


FIG. 5

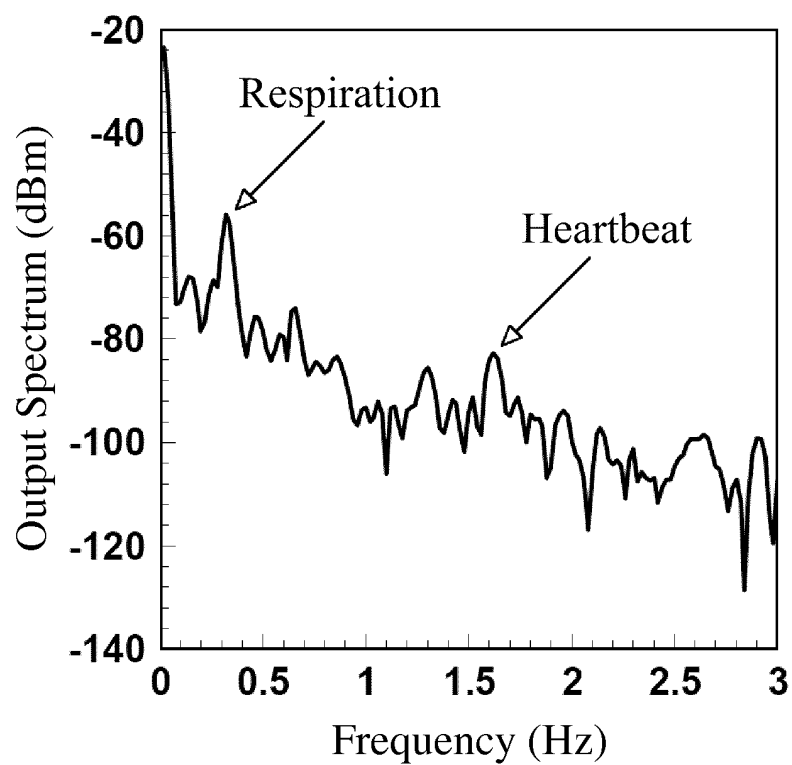


FIG. 6

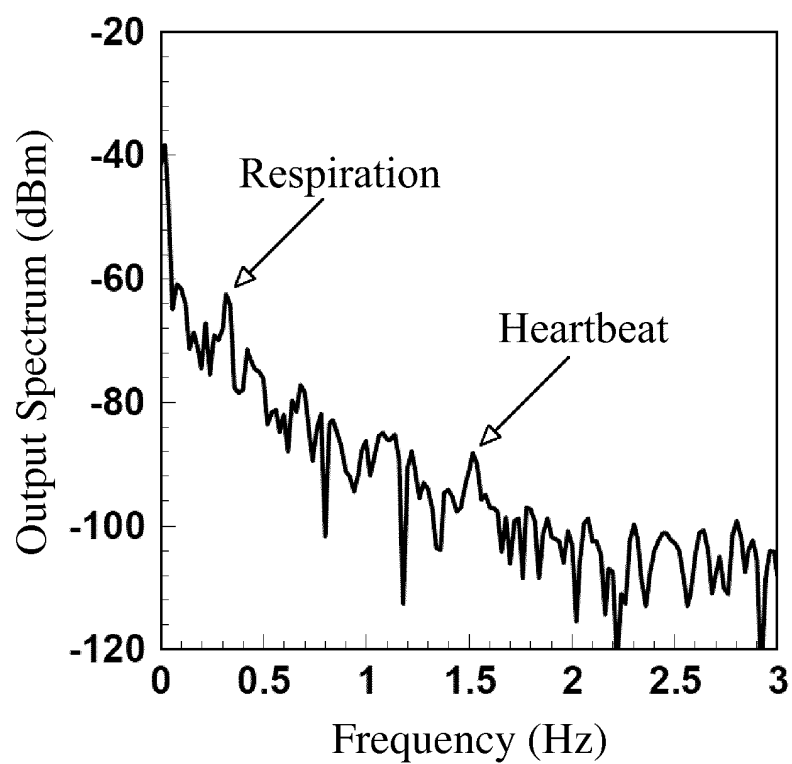


FIG. 7

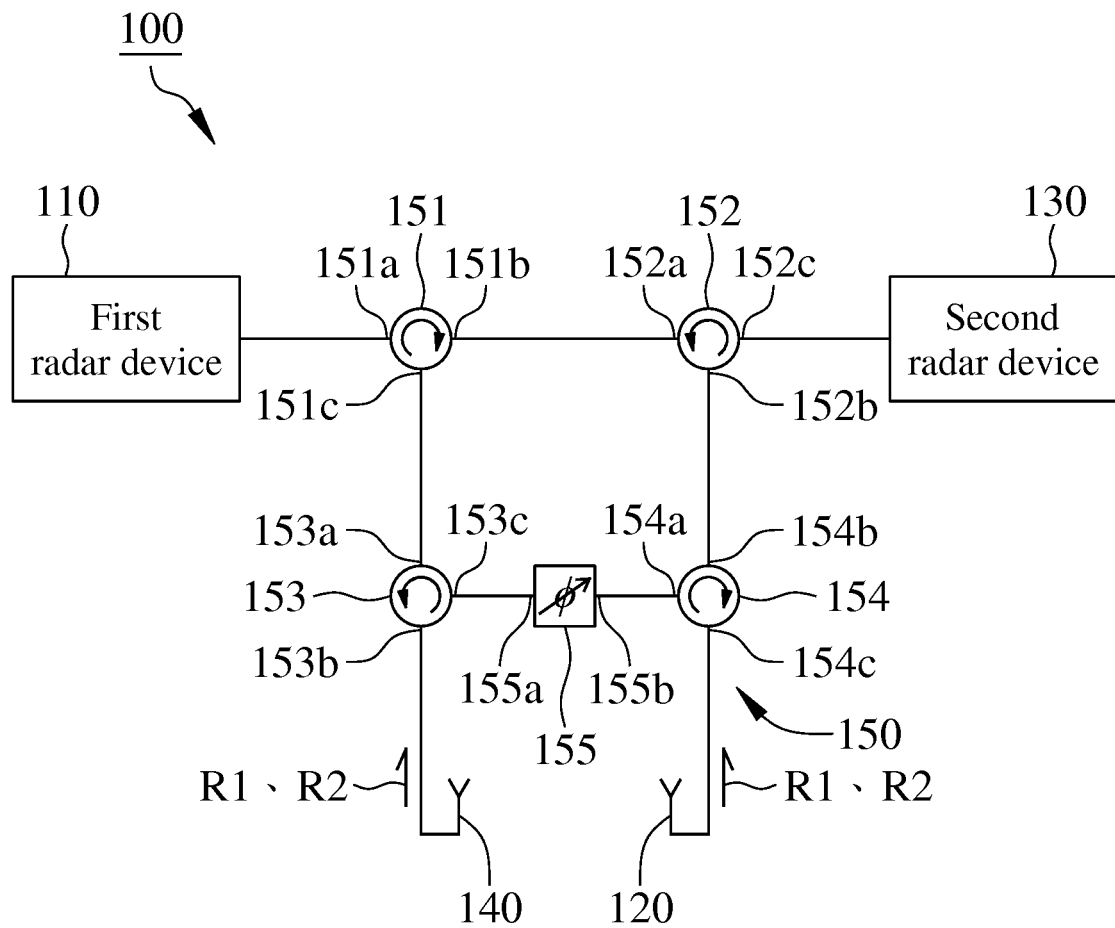


FIG. 8

REFERENCES CITED IN THE DESCRIPTION

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专利名称(译)	非接触式生命体征监测系统		
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当前申请(专利权)人(译)	国立中山大学		
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IPC分类号	A61B5/00 A61B5/0205 A61B5/05 G01S13/88 G01S7/03 G01S7/35 G01S7/40 G01S13/536 G01S13/87 A61B5/024 A61B5/08 G01S13/34		
CPC分类号	A61B5/0002 A61B5/0205 A61B5/024 A61B5/05 A61B5/0507 A61B5/0816 A61B5/7214 A61B5/7225 A61B5/7228 A61B5/7278 A61B2562/0228 A61B2562/04 G01S7/034 G01S7/354 G01S7/40 G01S13/34 G01S13/536 G01S13/87 G01S13/88		
优先权	105130608 2016-09-22 TW		
其他公开文献	EP3298956A1		
外部链接	Espacenet		

摘要(译)

非接触式生命体征监测系统通过具有不同增益的两个天线将无线信号传输到生物对象的同一侧，并且这两个天线以随机的身体运动从生物对象接收两个反射信号。在正确设置两个天线的情况下，可以通过振幅和相位调整单元来调整两个反射信号，以使由人体运动引起的多普勒频移分量具有相同的幅度和相位，而由生命体征引起的多普勒频移分量具有相同的幅度。不同的幅度。因此，在使用该系统来监视对象的生命体征时，可以基于两个反射信号之间的关系来消除随机的身体运动效果。

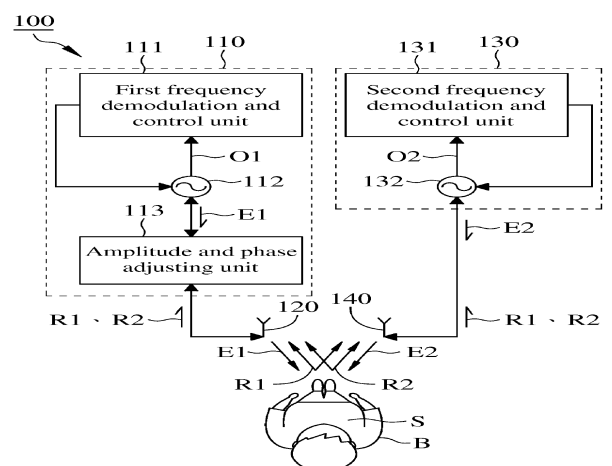


FIG. 1