

HOYU PATENT OFFICE

(FUJIMAKI PATENT OFFICE)

19th Floor, Yokohama Creation Square, 5-1 Sakae-cho, Kanagawa-ku,
Yokohama, Kanagawa 221-0052, Japan

Telephone: +81(45) 534-8261

Facsimile: +81(45) 534-8262

E-mail: fujimaki@hoyu-patent.com

Via E-mail and DHL

January 21, 2014

Mr. Sean M. McGinn
McGinn Intellectual Property Law Group, PLLC
8321 Old Courthouse Road,
Suite 200
Vienna, Virginia 22182-3817
U. S. A.

Re: New National Phase U. S. Patent Application
corresponding to PCT/JP2012/074299
Assignee: Mitsumasa SAITOH
Your Ref.: HOYU.023
Our Ref.: 12FI015PCT-US
Proposed Due Date: February 10, 2014
Priority Due Date: March 21, 2014

Dear Mr. McGinn:

Thank you very much for your e-mail of January 16, 2014
attaching the draft of Declaration and Power of Attorney.

Enclosed please find the executed Declaration and Power
of Attorney. Please submit it to the USPTO by the due date.

Please acknowledge receipt of this letter by return facsimile.

With best regards,

Very truly yours,

HOYU PATENT OFFICE

Masanori FUJIMAKI
Patent Attorney

MF/mmf
Enclsoure

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

DEVICE FOR SENSING HUMAN BODY ABNORMALITY BY STANDING-WAVE RADAR AND METHOD FOR USING SAME

the specification of which:
(check one)

 (is attached hereto)

 X was filed on September 21, 2012,
as Application Serial No. PCT/JP2012/074299
and was amended on . (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability of this application as defined in Title 37, Code of Federal Regulations, ' 1.56*, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under Title 35, United States Code, ' 119 or 365, of any foreign application(s) for patent or inventor's certificate or 365 of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below any foreign application for patent or inventor's certificate or PCT international application having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			priority claimed	
<u>2011-205460</u>	<u>JAPAN</u>	<u>September 21, 2011</u>	<u> X </u>	
(Number)	(Country)	(Day/Month/Year Filed)	yes	no
<u>2012-022579</u>	<u>JAPAN</u>	<u>February 4, 2012</u>	<u> X </u>	
(Number)	(Country)	(Day/Month/Year Filed)	yes	no
<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>
(Number)	(Country)	(Day/Month/Year Filed)	yes	no

I hereby claim the benefit under Title 35, United States Code, ' 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, ' 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, ' 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

<u> </u>	<u> </u>	<u> </u>
(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)

Power of Attorney: As a named inventor, I hereby appoint Sean M. McGinn, Esq., Reg. No. 34,386, and Customer No. **21254**, and the attorneys/agents associated therewith, as attorney and/or agent to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. All correspondence should be directed to **McGinn Intellectual Property Law Group, PLLC, Customer No. 21254, 8321 Old Courthouse Road, Suite 200, Vienna, Virginia 22182-3817**. Telephone calls should be directed to McGinn Intellectual Property Law Group, PLLC at (703) 761-4100.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole

Joint Inventor, If Any Mitsumasa SAITOH

Inventor's Signature

荻藤 光正

Date January 18, 2014

Residence

Yokohama-shi, Kanagawa, JAPAN

Citizenship

JAPAN

Post Office Address

7-8, Torigoe, Kanagawa-ku, Yokohama-shi, Kanagawa 221-0064, JAPAN

Full Name of Second

Joint Inventor, If Any

Inventor's Signature

Date

Residence

Citizenship

Post Office Address

Full Name of Third

Joint Inventor, If Any

Inventor's Signature

Date

Residence

Citizenship

Post Office Address

Full Name of Fourth

Joint Inventor, If Any

Inventor's Signature

Date

Residence

Citizenship

Post Office Address

(An additional sheet(s) is/are attached hereto if the present invention includes more than four inventors.)

*Title 37, Code of Federal Regulations, § 1.56:

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith toward the Patent and Trademark Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and (1) it establishes by itself or in combination with other information, a prima facie case of unpatentability; or (2) it refutes, or is inconsistent with, a position the applicant takes in: (i) opposing an argument of unpatentability relied on by the Office, or (ii) asserting an argument of patentability.

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Via E-mail and DHL Courier

January 10, 2014

Mr. Sean M. McGinn
McGinn Intellectual Property Law Group, PLLC
8321 Old Courthouse Road,
Suite 200
Vienna, Virginia 22182-3817
U. S. A.

Re: New National Phase U. S. Patent Application
corresponding to PCT/JP2012/074299

Assignee: Mitsumasa SAITOH

Our Ref.: 12FI015PCT-US

Proposed Due Date: February 10, 2014

Priority Due Date: March 21, 2014

Dear Mr. McGinn:

Thank you for your e-mail of December 26, 2013,
responding to our inquiry about the filing fees of the
national stage entry of the PCT application of the above-
identified PCT application.

We would like to ask you to represent the National Phase
U.S. Patent Application corresponding to the above-identified
PCT application.

Please file the national phase patent Application in
accordance with our information sheet **on or before February 10, 2014.**
The priority date of the Application is March 21, 2014. However, please file the
Application on or before February 10, 2014 and send us all of the filing documents by
February 15, 2014. Also, please send us your debit note by January 27, 2014. You
may forward us this debit note by e-mail attachment, because we have to charge all of
the fees in application including our fees to the Applicant by January 29, 2014.

This is a special procedure of the above-identified
application and a special procedure of the Filing thereof not
including the Office Action.

Also, please file a Preliminary Amendment in accordance
with our proposed amendment.

After you file this application with the U.S. Patent and

Trademark Office, please inform us of the filing date by facsimile.

Please prepare and send us draft Declaration and Power of Attorney as soon as possible by e-mail.

If you need any further information and documents, please let us know.

Please acknowledge receipt of this letter by return facsimile. Also, please keep the present application in force unless otherwise instructed.

With best regards,

Very truly yours,

HOYU PATENT OFFICE

Masanori FUJIMAKI
Patent Attorney

MF/mmff

Enclosures:

- | | | |
|------|---|----------------------|
| 1. | Information Sheet | 1 (E-mail & DHL) |
| 2. | Form PCT/IB/304 | 1 (E-mail & DHL) |
| 3. | Proposed Amendment | 1 (E-mail & DHL, CD- |
| R) | | |
| 4. | English Translation of International Application
PCT/JP2012/074299 | 1 (E-mail & DHL, CD- |
| ROM) | | |
| 5. | Formal Drawings (Figures 1-26)22 Sheets (E-mail & | |
| DHL) | | |
| 6. | PCT International Publication Pamphlet with ISR | 1 (E-mail & DHL, CD- |
| ROM) | | |
| 7. | Reference(s) cited in the specification of
PCT/JP2012/074299 and English Abstract(s) | 1 (DHL, CD-ROM) |
| 8. | Reference(s) cited in the International Search
Report and English Abstract(s) | 1 (DHL, CD-ROM) |
| 9. | CD-ROM | 1 (DHL) |

To follows

1. Declaration and Power of Attorney

INFORMATION SHEET

(NATIONAL PHASE PATENT APPLICATION IN U.S.A.)

Title of the Invention:

DEVICE FOR SENSING HUMAN BODY ABNORMALITY BY STANDING-WAVE
RADAR AND METHOD FOR USING SAME

Proposed Due Date: **February 10, 2014**

Due Date for Entry into the National Phase (30 months from the priority date) :
March 21, 2014

Our Reference No.: 12FI015PCT-US

PCT Application Number: PCT/JP2012/074299

International Filing Date: September 21, 2012

Priority of Japanese Application(s):

1. Japanese Patent Application No. 2011-205460 filed on September 21, 2011
2. Japanese Patent Application No. 2012-022579 filed on February 4, 2012

The application 2 required a domestic priority right based on the application 1.
The application 2 has allowed whose Patent No. is 5377689 and Registration Date:
October 4, 2013.

Applicant:

Name: Mitsumasa SAITOH
Address: 7-8, Torigoe, Kanagawa-ku, Yokohama-shi,
Kanagawa 221-0064, Japan
Nationality: Japanese Citizen

Inventor(s):

Name: Mitsumasa SAITOH
Address: 7-8, Torigoe, Kanagawa-ku, Yokohama-shi,
Kanagawa 221-0064, Japan
Nationality: Japanese Citizen

Remarks

The Applicant claim the Small Entity Status.

Amendment under PCT Article 19:	None
Demand for International Preliminary Examination:	None
Amendment under PCT Article 34:	None
Information of corresponding application:	Japan, Germany

From the INTERNATIONAL BUREAU

PCTNOTIFICATION CONCERNING SUBMISSION,
OBTENTION OR TRANSMITTAL
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

FUJIMAKI Masanori
HOYU PATENT OFFICE, 19th Floor, Yokohama
Creation Square, 5-1, Sakae-cho, Kanagawa-ku,
Yokohama-shi, Kanagawa
2210052
JAPON

Date of mailing (day/month/year) 16 November 2012 (16.11.2012)	
Applicant's or agent's file reference 12FI015PCT	IMPORTANT NOTIFICATION
International application No. PCT/JP2012/074299	International filing date (day/month/year) 21 September 2012 (21.09.2012)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 21 September 2011 (21.09.2011)
Applicant SAITOH Mitsumasa	

The applicant is hereby notified of the date of receipt (or of obtaining by the International Bureau) of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to the date of receipt, **the priority document concerned was submitted or transmitted to or obtained by the International Bureau in compliance with Rule 17.1(a), (b) or (b-bis)**. This Form replaces any previously issued notification concerning submission, transmittal or obtaining of priority documents.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
21 September 2011 (21.09.2011)	2011-205460	JP	15 November 2012 (15.11.2012)
04 February 2012 (04.02.2012)	2012-022579	JP	NR

The letters "NR" denote a priority document which, on the date of mailing of this Form, had not yet been received or obtained by the International Bureau in compliance with Rule 17.1(a), (b) or (b-bis). Where the applicant has failed to either submit, request to prepare and transmit, or to request the International Bureau to obtain the priority document within the applicable time limit under that Rule, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

An asterisk "*" next to a date of receipt, denotes a priority document submitted or transmitted to or obtained by the International Bureau but not in compliance with Rule 17.1(a), (b) or (b-bis) (the priority document was received after the time limit prescribed in Rule 17.1(a); the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b) or the request to the International Bureau to obtain the priority document was made after the applicable time limit under Rule 17.1(b-bis)). Even though the priority document was not furnished in compliance with Rule 17.1(a), (b) or (b-bis), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Masashi Honda e-mail pt08.pct@wipo.int Telephone No. +41 22 338 74 08
Facsimile No. +41 22 338 70 10	

Proposed Amendment

Re: New National Phase U. S. Patent Application
corresponding to PCT/JP2012/074299

Assignee : Mitsumasa SAITOH

Our Ref. : 12FI015PCT-US

Proposed Duea Date: February 10, 2014

Priority Due Date: March 21, 2014

In the Specification:

No amendment

In the Claims:

Please amend the claims as seen from the attached
"proposed amendment of claims" so as to change the multiple
dependent claims to single dependent claims.

In the Drawings:

No amendment

Proposed Amendment of Claims:

1. A device for sensing human body abnormality using standing-wave radar, comprising:

a standing-wave sensor for externally transmitting a frequency-swept radio wave, detecting, at two points separated by a fixed distance, a reflected wave received from an external reflection object based on the transmitted wavelength with λ being the wavelength of the transmitted wave, and sensing a standing wave combined from the transmitted wave and the received wave;

a computation unit for removing the DC component from the intensity distribution of the frequency of the combined wave sensed by said standing-wave sensor, performing a Fourier transform, obtaining a distance spectrum, and computing a change in phase and distance to said reflection object;

a signal processor for removing the distance component obtained when no person is present in a measurement space from the distance component to the obtained reflection object, and obtaining distance information that is different from the distance component obtained when no person is present in the measurement space to extract the distance component to a person to be measured who has entered into said measurement space; and

a determination unit for sensing an abnormality in a person to be measured from a variation in the intensity distribution of the component associated with the distance to the person to be measured and determining the physical

state of said person to be measured and the physiological state including a respiratory rate and pulse from said change in phase.

2. A device for sensing human body abnormality
5 using standing-wave radar, comprising:

a standing-wave sensor for externally transmitting a frequency-swept radio wave, detecting, at two points separated by a fixed distance, a reflected wave received from an external reflection object based on the transmitted
10 wavelength with λ being the wavelength of the transmitted wave, and sensing a standing wave combined from the transmitted wave and the received wave;

a computation unit for removing the DC component from the intensity distribution of the frequency of the combined
15 wave sensed by said standing-wave sensor, performing a Fourier transform, obtaining a distance spectrum, and computing from the distance spectrum of a first interval and the distance spectrum of a second interval in a single period a phase difference from the distance spectra and a
20 change in phase;

a signal processor for removing the distance component obtained when no person is present in a measurement space from the distance component to the reflection object obtained from said phase difference, and obtaining distance
25 information that is different from the distance component obtained when no person is present in the measurement space to extract the distance component to a person to be measured who has entered into said measurement space; and

a determination unit for sensing an abnormality in a person to be measured from a variation in the intensity distribution of the component associated with the distance to the person to be measured and determining the physical state of said person to be measured and the physiological state including a respiratory rate and pulse from said change in phase.

3. The device for sensing human body abnormality using standing-wave radar according to claim 1, comprising:

10 a case at least partially provided with a transparent cover; and

a LED light source as a light-emitting unit for irradiating illumination light to the exterior via said cover, the LED light source being housed in the case,

15 said standing-wave sensor, said computation unit, said signal processor, and said determination unit being housed in said case, and said standing-wave sensor transmitting/receiving radio waves via said cover and being housed in an LED illumination apparatus.

20 4. The device for sensing human body abnormality using standing-wave radar according to claim 3, wherein a power supply unit comprising a connector that can be mounted in a light bulb socket or sealing is disposed below said case, and power is supplied to said LED light source and said standing-wave sensor via the power supply unit.

25 5. The device for sensing human body abnormality using standing-wave radar according to claim 3, wherein said computation unit, said signal processor, and said

determination unit are housed in said case as a module together with said standing-wave sensor.

6. The device for sensing human body abnormality using standing-wave radar according to claim 1, wherein said
5 determination unit transmits an alarm signal to an external alarm signal receiver when the distance to said person to be measured, or the respiratory rate or pulse of said person to be measured has been determined to be in a danger area set in advance.

10 7. The device for sensing human body abnormality using standing-wave radar according to claim 3, wherein said determination unit emits an alarm by turning said LED illumination apparatus on and off, or varying the light modulation, when the distance to said person to be measured,
15 or the respiratory rate or pulse of said person to be measured has been determined to be in a danger area set in advance.

8. A method for using a device for sensing human body abnormality using standing-wave radar, wherein the
20 device for sensing human body abnormality using standing-wave radar according to claim 1 is installed in a ceiling of a building or residence to determine an abnormality of a human body inside the residence or building.

9. A method for using a device for sensing human
25 body abnormality using standing-wave radar, wherein the device for sensing human body abnormality using standing-wave radar according to claim 1 is installed in a ceiling of a vehicle or a ceiling of passage or tunnel to determine

congestion of human bodies therein.

10. A method for using a device for sensing human body abnormality using standing-wave radar, wherein the device for sensing human body abnormality implemented by the
5 standing-wave radar-integrated LED illumination apparatus according to claim 3 is installed for illuminating a road using said LED light source, and a water level of water that has flooded the road and congestion of human bodies positioned in the road are determined.

10 11. The device for sensing human body abnormality using standing-wave radar according to claim 2, comprising:

a case at least partially provided with a transparent cover; and

15 a LED light source as a light-emitting unit for irradiating illumination light to the exterior via said cover, the LED light source being housed in the case,

said standing-wave sensor, said computation unit, said signal processor, and said determination unit being housed in said case, and said standing-wave sensor
20 transmitting/receiving radio waves via said cover and being housed in an LED illumination apparatus.

12. The device for sensing human body abnormality using standing-wave radar according to claim 11, wherein a power supply unit comprising a connector that can be mounted in a
25 light bulb socket or sealing is disposed below said case, and power is supplied to said LED light source and said standing-wave sensor via the power supply unit.

13. The device for sensing human body abnormality using

standing-wave radar according to claim 11, wherein said computation unit, said signal processor, and said determination unit are housed in said case as a module together with said standing-wave sensor.

5 14. The device for sensing human body abnormality using standing-wave radar according to claim 2, wherein said determination unit transmits an alarm signal to an external alarm signal receiver when the distance to said person to be measured, or the respiratory rate or pulse of said person to
10 be measured has been determined to be in a danger area set in advance.

15 15. The device for sensing human body abnormality using standing-wave radar according to claim 11, wherein said determination unit emits an alarm by turning said LED illumination apparatus on and off, or varying the light modulation, when the distance to said person to be measured, or the respiratory rate or pulse of said person to be measured has been determined to be in a danger area set in advance.

20 16. A method for using a device for sensing human body abnormality using standing-wave radar, wherein the device for sensing human body abnormality using standing-wave radar according to claim 2 is installed in a ceiling of a building or residence to determine an abnormality of a
25 human body inside the residence or building.

17. A method for using a device for sensing human body abnormality using standing-wave radar, wherein the device for sensing human body abnormality using standing-

wave radar according to claim 2 is installed in a ceiling of a vehicle or a ceiling of passage or tunnel to determine congestion of human bodies therein.

18. A method for using a device for sensing human
5 body abnormality using standing-wave radar, wherein the device for sensing human body abnormality implemented by the standing-wave radar-integrated LED illumination apparatus according to claim 11 is installed for illuminating a road using said LED light source, and a water level of water that
10 has flooded the road and congestion of human bodies positioned in the road are determined.

DESCRIPTION

DEVICE FOR SENSING HUMAN BODY ABNORMALITY BY STANDING-WAVE
RADAR AND METHOD FOR USING SAME

TECHNICAL FIELD

5 [0001]

The present invention relates to a light-emitting diode (LED) illumination apparatus, and more particularly relates to a device for sensing human body abnormality using standing-wave radar provided with a function for sensing a
10 danger situation of a human body positioned below an illumination apparatus using a standing-wave radar, and to a method for using same.

BACKGROUND ART

[0002]

15 A conventional illumination apparatus for sensing a human body senses a human body using an infrared sensor, an ultrasonic sensor or Doppler sensor, and controls the on and off state of illumination (Patent Documents 4 and 5), but cannot sense a danger situation of a human body.

20 [0003]

Patent Document 1 discloses a system having a radio wave sensor for emitting radio waves and for receiving reflected waves thereof, a detector for detecting the phase and amplitude of signals received by the radio wave sensor
25 to obtain detection signals, and a signal processor for measuring the current position, movement, respiratory rate, and heart rate of an animal or resident from the detection signal to determine the presence of an animal or resident,

the system being used as resident monitoring system that can be readily installed in residences to be monitored having a variety of floor plans, and that is capable of readily ascertaining the behavior dynamics of residents and changes
5 in the living space.

[0004]

Patent Document 2 discloses a non-contact cardiopulmonary function monitoring device provided with a radio wave sensor for detecting the movements of a monitored
10 object using the Doppler effect, wherein movement signals are passed through a respiratory rate filter in which the frequency band of a respiratory rate is used as a pass frequency band, and are passed through a heart rate filter in which the frequency band of a heart rate is used as a
15 pass frequency band, and the respiratory rate and heart rate are calculated from the maximum amplitude in each pass frequency band.

[0005]

Furthermore, Patent Document 3 discloses a monitoring
20 system for transmitting and receiving radio waves in a residence, extracting a respiration signal in a frequency band corresponding to the respiration of a resident and a movement signal in a higher frequency band than the respiration signal, from a signal that corresponds to a
25 reflected wave received by a radio wave sensor, and determining that the resident is in an abnormal state when the resident has not moved for a fixed length of time or longer, on the basis of the movement signal, while the

respiratory signal is detected (claim 1). Also, the radio wave sensor is a Doppler sensor (claim 3).

[0006]

Patent Document 1: Japanese Laid-open Patent

5 Application No. 2010-66877

Patent Document 2: Japanese Patent No. 3057438

Patent Document 3: Japanese Laid-open Patent

Application No. 2006-285795

Patent Document 4: Japanese Laid-open Patent

10 Application No. 2011-34938

Patent Document 5: Japanese Laid-open Patent

Application No. 2003-132704

DISCLOSURE OF THE INVENTION

Problems the Invention Is Intended to Solve

15 [0007]

However, the conventional technique described in Patent Document 1 detects respiratory rate and heart rate of a person from the phase or amplitude detected by a plurality of radio wave sensors installed in each room (paragraph [0007]), but in relation to the position information of a resident, this conventional technique merely determines the position of a resident by assuming a resident is positioned in an area monitored by a sensor in which the phase or amplitude is fluctuating, and that a resident is not present in an area monitored by a sensor in which the phase or amplitude is not fluctuating (paragraph [0013]). In this manner, in relation to the position of a resident, only position information about which room a resident is in can

20

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be detected in Patent Document 1. In relation to an abnormality of a resident, an abnormality is determined in the case that the resident is in a location for a long period of time that the resident does not ordinarily remain
5 for a long period of time (paragraph [0026]). Therefore, an abnormality of a person cannot be rapidly detected with high precision in Patent Document 1.

[0008]

In the case that the amplitude and phase of a received
10 signal of a reflected wave of an emitted radio wave are to be detected in accordance with Patent Document 1, the distance at which the amplitude and phase of the radio wave can be detected must be several meters or more away, and only the amplitude and phase of reflected waves from the
15 position several meters or more away can be detected. When the detector is a Doppler radar, the heart rate and respiratory rate can be detected at a close distance, but a Doppler radar detects changed in the frequency of reflected waves, and the heart rate and respiratory rate cannot
20 therefore be detected using only changes in the amplitude and phase of a signal, as is the case in Patent Document 1.

[0009]

Furthermore, in Patent Documents 2 and 3, the frequency of the maximum amplitude is calculated from a signal
25 detected using the Doppler effect as the respiratory rate and the heart rate, but since this is a Doppler scheme, the speed of an object can be detected, but the distance cannot be detected. Consequently, Patent Documents 2 and 3 cannot

detect the position of a human body.

[0010]

The present invention was devised in view of these problems, and an object thereof is to provide a device for
5 sensing a human body abnormality using standing-wave radar and a method for using the same, which are capable of detecting the position of a human body, and the respiratory rate, heart rate, and the like thereof, and rapidly sensing sudden changes to the condition of the detected human body,
10 by merely installing the present invention in lieu of existing illumination apparatuses installed in restrooms, bathing rooms, corridors, and the like.

[0011]

Means for Solving the Problems

15 The device for detecting human body abnormality using standing-wave radar according to the present invention comprises:

a standing-wave sensor for externally transmitting a frequency-swept radio wave, detecting, at two points
20 separated by a fixed distance, a reflected wave received from an external reflection object based on the transmitted wavelength with λ being the wavelength of the transmitted wave, and sensing a standing wave combined from the transmitted wave and the received wave;

25 a computation unit for removing the DC component from the intensity distribution of the frequency of the combined wave sensed by the standing-wave sensor, performing a Fourier transform, obtaining a distance spectrum, and

computing a change in phase and distance to the reflection object;

5 a signal processor for removing the distance component obtained when no person is present in a measurement space from the distance component to the obtained reflection object, and obtaining distance information that is different from the distance component obtained when no person is present in the measurement space to extract the distance component to a person to be measured who has entered into
10 the measurement space; and

a determination unit for sensing an abnormality in a person to be measured from a variation in the intensity distribution of the component associated with the distance to the person to be measured and determining the physical
15 state of the person to be measured and the physiological state including a respiratory rate and pulse from the change in phase.

[0012]

The device for detecting human body abnormality using
20 standing-wave radar according to the present invention comprises:

a standing-wave sensor for externally transmitting a frequency-swept radio wave, detecting, at two points separated by a fixed distance, a reflected wave received
25 from an external reflection object based on the transmitted wavelength with λ being the wavelength of the transmitted wave, and sensing a standing wave combined from the transmitted wave and the received wave;

a computation unit for removing the DC component from the intensity distribution of the frequency of the combined wave sensed by the standing-wave sensor, performing a Fourier transform, obtaining a distance spectrum, and
5 computing from the distance spectrum of a first interval and the distance spectrum of a second interval in a single period a phase difference from two distance spectra and a change in phase;

a signal processor for removing the distance component
10 obtained when no person is present in a measurement space from the distance component to the reflection object obtained from the phase difference, and obtaining distance information that is different from the distance component obtained when no person is present in the measurement space
15 to extract the distance component to a person to be measured who has entered into the measurement space; and

a determination unit for sensing an abnormality in a person to be measured from a variation in the intensity distribution of the component associated with the distance
20 to the person to be measured and determining the physical state of the person to be measured and the physiological state including a respiratory rate and pulse from the change in phase.

[0013]

25 The standing-wave radar-integrated LED illumination apparatus of the present invention, wherein, e.g., a power supply unit composed of a connector that can be mounted in a light bulb socket or sealing is disposed below the case, and

power is supplied to the LED light source and the standing-wave sensor via the power supply unit.

[0014]

The standing-wave radar-integrated LED illumination
5 apparatus of the present invention, wherein, e.g., the
computation unit, the signal processor, and the
determination unit are housed in the case as a module
together with the standing-wave sensor.

[0015]

10 Furthermore, in the standing-wave radar-integrated LED
illumination apparatus of the present invention, e.g., the
determination unit emits an alarm by transmitting an alarm
signal to an external alarm signal receiver when the
distance to the person to be measured, or the respiratory
15 rate or pulse of the person to be measured has been
determined to be in a danger area set in advance.

[0016]

In the method for using the standing-wave radar-
integrated LED illumination apparatus of the present
20 invention, the standing-wave radar-integrated LED
illumination apparatus of the present invention described
above is installed in a ceiling of a building or residence
to determine an abnormality of a human body inside the
residence or building.

25 [0017]

In the method for using the standing-wave radar-
integrated LED illumination apparatus of the present
invention, the standing-wave radar-integrated LED

illumination apparatus described above is installed in a ceiling of a vehicle or a ceiling of passage or tunnel to determine congestion of human bodies therein.

[0018]

5 In the method for using the standing-wave radar-integrated LED illumination apparatus of the present invention, the standing-wave radar-integrated LED illumination apparatus described above is installed for illuminating a road, and a water level of water that has
10 flooded a road and congestion of human bodies positioned in the road are determined.

Effects of the Invention

[0019]

According to the present invention, it is possible to
15 measure with high precision the distance to a person being measured from a very small distance to a distant location and to measure the respiratory rate, pulse, and other very small displacements of a person being measured, by analyzing standing waves.

20 BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a view of the external appearance of the LED illumination apparatus according to embodiments of the present invention;

25 FIG. 2 is a longitudinal sectional view the same showing the structure thereof;

FIG. 3 is a block diagram of the radar control module board 7, the standing-wave radar module 8, and the LED

control unit 10 of the same;

FIG. 4 represents the basic configuration of a standing-wave radar;

FIG. 5 represents wavelength of a transmitted wave;

5 FIG. 6 represents the power of a combined wave;

FIG. 7 is a view of post Fourier conversion;

FIG. 8 represents the power of a combined wave;

FIG. 9 represents the basic configuration of a standing-wave radar in relation to a plurality of targets;

10 FIG. 10 is a spectral view showing the objective component $p_a(f_d, 0)$;

FIG. 11 represents a distance spectrum in the case of two targets;

15 FIG. 12 represents the anti-logarithm portion and the imaginary number portion of the spectrum of a combined wave;

FIG. 13 illustrates the detection positions of a reflected wave;

FIG. 14 is a block diagram and waveform diagram showing another embodiment of the present invention;

20 FIG. 15 represents a principle of measuring distance;

FIG. 16 similarly represents a principle of measuring distance;

25 FIG. 17 represents the usage method when the LED illumination apparatus of an embodiment of the present invention has been installed in a restroom;

FIG. 18 represents the usage method when the LED illumination apparatus of an embodiment of the present invention has been installed in a bathing room;

FIG. 19 represents the usage method when the LED illumination apparatus of an embodiment of the present invention has been installed in a hallway;

FIG. 20 represents a typical abnormal respiratory
5 pattern;

FIG. 21 represents the state in which the LED illumination apparatus of an embodiment of the present invention is used for monitoring the interior of a passenger train;

10 FIG. 22 represents the state in which the LED illumination apparatus of an embodiment of the present invention is used for monitoring road conditions;

FIG. 23 represents a directly under-type illumination apparatus;

15 FIG. 24 represents an illumination apparatus in a light guide scheme;

FIG. 25 is a chart obtained by measuring the respiratory period by detecting very small displacement; and

FIG. 26 represents a respiratory rhythm.

20 BEST MODE FOR CARRYING OUT THE INVENTION

[0021]

Next, embodiments of the present invention will be described in detail with reference to the attached drawings. FIG. 1 is a view of the external appearance of the standing-wave radar-integrated LED illumination apparatus according
25 to embodiments of the present invention. A case of the LED illumination apparatus is composed of: a metal cap 1 that can be mounted in an existing socket; a case main body 2

having a heat-dissipating function and being formed from ABS or another resin material, or an aluminum material or the like; and a translucent cover 3 composed of a transparent or semitransparent ABS or polycarbonate or the like translucent resin material, or glass or the like. The translucent cover 3 has a lens shape for scattering light or narrowing a light beam. In lieu of a metal cap 1, some illumination apparatuses have a hook sealing 4 for hooking and mounting on the sealing of a ceiling. In this manner, there are numerous LED illumination apparatuses, and the present invention can be applied to any LED illumination apparatus.

[0022]

FIG. 2 represents the structure of an LED illumination apparatus according to an embodiment of the present invention. In the LED illumination apparatus, a surface-mounted LED 6, a standing-wave radar module 8, and a LED control unit 10 are accommodated inside a case composed of the metal cap 1, the case main body 2, and the cover 3. The lower half portion of the metal cap 1 is threadably inserted into a socket and is formed from an electroconductive material. The upper half portion of the metal cap 1 is an insulating support body. A threaded part 1a is provided to the upper end part of the insulating support body of the metal cap 1, the threaded part 1a being extended along the inner peripheral edge part thereof in peripheral direction. A threaded part 2a is also provided to the upper end part of the case main body 2, the threaded part 2a being extended along the outer peripheral edge part thereof in peripheral

direction. The threaded part 1a is screwed onto the threaded part 2a, whereby the metal cap 1 and the case main body 2 are coupled together. Also, a threaded part 2b is formed on the upper part of the case main body 2, a threaded
5 part 3a is formed in the lower end part of the cover 3, and the threaded part 3a is screwed onto the threaded part 2b, whereby the cover 3 and the case main body 2 are coupled together.

[0023]

10 An insulating guide frame 12 for securing a board is disposed inside the case main body 2, and a board 11 of the LED control unit 10 is secured to the guide frame 12. The board 11 is secured to the guide frame 12 such that the surface thereof is in the vertical direction, i.e., such
15 that the surface of the board 11 is parallel to the center axis of the illumination apparatus. The LED control unit 10 is mounted on the board 11 and is arranged within the space enclosed by the case main body 2 and the metal cap 1. An externally supplied 100-V AC power is fed to the board 11
20 inside the metal cap 1, and the power is AC-DC converted by a converter mounted on the board 11, and is thereafter fed to the LED control unit 10.

[0024]

25 An aluminum board 5 having excellent heat dissipation is arranged with the surface thereof horizontal on the upper end part of the case main body 2. The aluminum board 5 is supported by the edge part of the upper end part of the case main body 2, and the board 11 is inserted through the

aluminum board 5 so as to protrude into the cover 3 area.
The radar control module board 7 is supported with the
surface thereof horizontal on the upper end part of the
board 11, and the standing-wave radar module 8 is mounted on
5 the radar control module board 7. A plurality (seven in the
illustrated example) of LEDs 6 is arranged in positions
equivalently distributed about the center axis of the
illumination apparatus, i.e., in positions of equidistant
intervals at the outer periphery. Wiring for the board 11
10 is connected to the power line of the aluminum board 5, the
LEDs 6 mounted on the aluminum board 5 are supplied with
power by the LED control unit 10 via the wiring for the
board 11 to cause the LEDs 6 to emit light. Power is
supplied via the board 11 to the standing-wave radar module
15 8 mounted on the radar control module board 7. The
standing-wave radar module 8 transmits/receives microwaves
or other radio waves, and the radar control module board 7
wirelessly transmits detection signals to an external relay
apparatus. An antenna 8a is disposed on the upper surface
20 of the standing-wave radar module 8, and radio waves are
transmitted/received via the antenna 8a. The standing-wave
radar module 8 is capable of being inclined in relation to
the radar control module board 7, and the standing-wave
radar module 8 is inclined to thereby allow the orientation
25 of the antenna 8a to be adjusted.

[0025]

FIG. 3 is a block diagram of the radar control module
board 7, the standing-wave radar module 8, and the LED

control unit 10. AC power at 100 V is inputted from an external power source to a power supply block 21 of the LED control unit 10, converted to DC power by an AC-DC converter of the power supply block 21, and inputted to an internal
5 power regulator 23. A DC 5-V power is fed to the standing-wave radar module 8 and a LED controller microcomputer 24. The output of the AC-DC converter is fed to a LED driver 22 as well and used for driving the LEDs 6. The LED controller microcomputer 24 receives control signals from the standing-
10 wave radar module 8, and outputs a LED on/off control signal and a light modulation control signal to the LED driver 22. The LED driver 22 drives the LEDs 6 on the basis of these control signals.

[0026]

15 A computation unit 31 is provided to the radar control module board 7. The computation unit 31 generates a frequency control voltage that has been FM-modulated by a modulation signal generator 38, the frequency control voltage is inputted to the control input of the VCO of a 24-
20 GHz high-frequency module 35 after the frequency control signal converted to an analog signal by a DA converter 39 has been amplified via an operational amplifier 40. The VCO is made to sweep the frequency of the emitted radio wave by the frequency control signal.

25 [0027]

The 24-GHz high-frequency transceiver 35 is provided to the standing-wave radar module 8. The 24-GHz high-frequency transceiver 35 is a module in which a 24-GHz band VCO

(voltage control oscillator) and flat antenna 8a have been integrated. With this transceiver 35, microwaves are emitted from the flat antenna 8a via the VCO and the reflected waves from the reflected body are detected by the antenna 8a. Two wave detectors 36a, 36b are housed in the transceiver 35, and the wave detectors 36a, 36b detect transmitted waves and received waves.

[0028]

When radio waves are transmitted from the antenna 8a and a reflection object is present, reflected waves return to the antenna 8a and superimposed waves having the same frequency yet different travel directions result in a standing wave. A transmitted signal (traveling wave) and a received signal (reflected wave) exist together in the antenna power supply unit and in the pathway connecting the VCO and antenna 8a, and these signals combined produce a standing wave. In this case, the sweep voltage fed to the VCO must be held constant at least during the time that the emitted radio wave is reflected from the reflection object and returns. Therefore, the sweep voltage must be varied in a stepwise fashion. The VCO is controlled so as to sequentially switch the frequency, whereby the signal level of mixed waves for a plurality of frequencies is detected by the wave detectors 36a, 36b. The power of the transmitted waves, the power of the reflected waves, and a component produced by the standing wave are detected by the wave detectors 36a, 36b. The resulting detected-wave signals are amplified in the required frequency band of 400 kHz or less

by the operational amplifiers 37a, 37b, are converted to a digital signal by an AD converter 41 inside the computation unit 31, and are thereafter inputted to a signal processor 42. The inputted signals have a period that is inversely
5 proportional to the distance from the reflection object and are therefore made to undergo a Fourier transform in the signal processor 42 to thereby obtain a frequency which is the reciprocal of the period, whereby the distance to a reflection object can be obtained. Information about very
10 small displacements of a reflection object can be detected on the basis of the phase of the resulting waveform. For example, in the case of 24 GHz, a very small displacement is a value obtained by dividing the speed of light by $4\pi f$, and displacements in the range of about ± 3.125 mm can be
15 detected. In this manner, the signals detected by the wave detectors 36a, 36b are made to undergo signal processing, the distance from the reflection object and the speed and displacement of the reflection object are computed, and chronological changes thereof are measured, whereby movement
20 of the reflection object can be detected. The movement of the reflection object is analyzed by the computation unit 42, the results are outputted to an alarm unit 43, the alarm unit 43 outputs to the LED controller microcomputer 24 a control signal that causes LEDs to switch on, blink, switch
25 off, causes an alarm to switch on and off, or causes another action.

[0029]

The computation unit 31 transmits the obtained state of

the reflection object to the exterior, wirelessly via a high-frequency unit 32 and wired by a output terminal 33. Also, the computation unit 31 emits an alarm sound via an audio amplifier 34. Any means among wireless transmission,
5 wired transmission, and alarm sound may be used.

[0030]

Next, the operation of an embodiment of the present invention will be described together with the configuration of the signal processor 42. A standing wave is produced by
10 interference between a transmitted wave VT generated from the VCO, which is the signal source, and reflected waves VR1, VR2, VR3, ..., VRn from a target, as shown in FIG. 4. The standing-wave radar senses the existence of a target by using this standing wave, and measures the distance d1, d2,
15 d3, ..., dn to the target.

[0031]

The transmitted wave (traveling wave) is represented by Formula 1, where A is the amplitude of the signal source, f is the frequency, and c is the speed of light (3×10^8 m/s).
20 However, the frequency f is represented by f0 and fd, as shown in FIG. 5.

[0032]

[Formula 1]

$$V_T = Ae^{j2\pi \int f(t - \frac{x}{c})d(t - \frac{x}{c})}$$

25 [0033]

The reflected wave from the target can be represented by Formula 2 below, where dk is the distance to the kth

target, γ_k (magnitude of the reflection coefficient) is the ratio of the magnitude of the reflected wave with respect to the transmitted wave at an arbitrary point on the x axis, and ϕ_k (phase of the reflection coefficient) is the phase difference.

[0034]

[Formula 2]

$$V_{Rk} = A\gamma_k e^{j\phi_k} e^{j2\pi \int f(t - \frac{2d-x}{c}) dt}$$

[0035]

The detection wave output detected by the antenna results in a combined wave, and the amplitude V_c is therefore represented by Formula 3 below. The power is the square of the amplitude, and the power of the combined wave is therefore represented by Formula 4 below.

[0036]

[Formula 3]

$$V_C = V_T + \sum_{k=1}^n V_{Rk}$$

[0037]

[Formula 4]

$$p(f_d, x) = \left| V_T + \sum_{k=1}^n V_{Rk} \right|^2$$

[0038]

The magnitude of the transmitted wave is greater than the magnitude of the reflected wave by a magnitude of one,

where γ_k is considerably less than 1. In view of this fact, Formula 1 and Formula 2 are substituted into Formula 4 to obtain an approximated value, resulting in Formula 5.

[0039]

5 [Formula 5]

$$p(f_d, x_s) \approx$$

$$A^2 \left\{ 1 + \sum_{k=1}^n \gamma_k^2 + 2 \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi f_d}{c} (d_k - x_s) + \frac{4\pi f_0}{c} (d_k - x_s) - \phi_k \right) \right\}$$

[0040]

In Formula 5, the first term in the brackets ($\{ \}$) represents the power of the transmitted wave, the second
10 term represents the power of the reflected wave, and the third term represents the change in power by the standing wave. A conventional radar receives a reflected wave, which is the second term, and performs signal processing, but in the present invention, the signal of the third term
15 undergoes signal processing. Consequently, since the first and second terms are to be deleted, the combined wave power $p(f_d, x_s)$ is differentiated by f_d , and the first and second terms are deleted.

[0041]

20 Here, when the number of targets (reflection objects) is 1, $n = 1$ is substituted into Formula 5 to obtain Formula 6 below. FIG. 6 is a result of forming a graph based on Formula 6. In other words, the power of the combined wave is the sum of a fixed value $1 + \gamma^2$ and the periodic
25 function. In FIG. 6, the frequency (reciprocal of the period) of the periodic function is $c/2d$, which give

consideration to the distance d component. Consequently,
obtaining the frequency from the period results in obtaining
the distance d. The DC component $1 + \gamma^2$ is removed from
Formula 6 and a Fourier transform is carried out, whereupon
5 a distance spectrum $P(x)$ is obtained, as shown in FIG. 7.

[0042]

[Formula 6]

$$p(f, 0) = 1 + \gamma^2 + 2 \gamma \cos(2\pi \frac{2d}{c} f - \Phi)$$

[0043]

10 First, the variables are substituted in the Fourier
transform formula shown in Formula 7 below and a Fourier
transform is carried out using the observation position as
the origin to thereby obtain the distance spectrum shown in
Formula 8 below. In the formula, $Sa(z) = \sin(z)/z$. In
15 Formula 8, the DC portion has not be cut. When a function
having a period is Fourier-expanded, it is broken down into
oscillation components (sin, cos) and the DC component
included in the function. In terms of a formula, the
distance spectrum is displayed in the manner shown in
20 Formula 8 below.

[0044]

[Formula 7]

Fourier transform formula $F(\omega) = \int_{-\infty}^{\infty} f(t) e^{-j\omega t} dt$

Variable substitution $t \Rightarrow f_d \quad \frac{\omega}{2\pi} \Rightarrow \frac{2x}{c} \quad f(t) \Rightarrow p(f_d, x_s)$

Let the observation position be the origin $\Rightarrow x_s = 0$

[0045]

[Formula 8]

$$P(x) = \int_{-f_W/2}^{+f_W/2} p(f_d, 0) e^{-j \frac{4\pi x f_d}{c}} df_d =$$

$$A^2 f_W \left\{ \left(1 + \sum_{k=1}^n \gamma_k^2 \right) \text{Sa} \left(\frac{2\pi f_W}{c} x \right) + \sum_{k=1}^n \gamma_k e^{-j \phi_k} e^{j \frac{4\pi f_0 d_k}{c}} \text{Sa} \left(\frac{2\pi f_W}{c} (x - d_k) \right) + \right.$$

$$\left. \sum_{k=1}^n \gamma_k e^{j \phi_k} e^{-j \frac{4\pi f_0 d_k}{c}} \text{Sa} \left(\frac{2\pi f_W}{c} (x + d_k) \right) \right\}$$

[0046]

5 $A^2 f_w (1 + \sum \gamma_k^2) \text{Sa}(2\pi f_w / c) x$ in Formula 8 is the DC component, and this DC component is removed by a capacitor in a real circuit.

[0047]

FIG. 8 shows the case in which the power P(x)

10 represented by the third expression in Formula 8 is viewed in a graph. The DC component, which is the first term in the brackets ({}) in Formula 8, is removed, the cos component, which is the third term, is converted to a complex sinusoidal wave (analysis signal) and removed, and

15 the component of the second term, which is the standing wave component, can be extracted out. However, a signal on the imaginary number side leaks into the second term component in the braces ("{}") of Formula 8, as shown by the broken line in FIG. 8. In other words, the standing wave component

20 of this portion is a value in which a signal on the imaginary number side has leaked in.

[0048]

In order to solve such problems, when signal obtained by combining the transmitted wave and the reflected wave is

25 detected in the present invention, the signal level is

detected at two points at a distance of $\lambda/8$ from each other, where λ is the wavelength of the transmitted wave, as shown in FIG. 9. In other words, when the x axis is the travel direction of the radar, the antenna receives a reflected
5 wave from n targets, which are the reflection objects (where n is a natural number; only two are shown). This is detected together with the transmitted wave by two power detectors set at a distance of $\lambda/8$ from each other in the x-axis direction, and this undergoes signal processing. At
10 this point, the power of the detector positioned at $x_1 = 0$ is obtained as $p(f_d, 0)$ shown in Formula 9 below by substituting $x_1 = x_s = 0$ into Formula 5, which shows the detection power, and the power of the detector positioned at $x_1 = -\lambda/8$ is obtained as $p(f_d, -\lambda/8)$ shown in Formula 9 below
15 by substituting $x_2 = x_s = -\lambda/8$ into Formula 5, which shows the detection power, where $p(f_d, x_1)$ and $p(f_d, x_2)$ are the power levels detected by the two detectors. As shown in Formula 9, a standing wave is detected as two points set at a distance of $\lambda/8$ from each other, whereby the orthogonal
20 component of cos and sin is obtained in the standing-wave component outputted by the detector positioned at each $(0, -\lambda/8)$, and it is thereby possible to remove the effect of the signal that has leaked in from the imaginary image side. In other words, this is an analysis signal obtained by a vector
25 in which the orthogonal components of cos and sin (the X-axis component and the Y-axis component) have been combined. Ordinarily, a signal on the imaginary axis side cannot be measured, but the signal on the imaginary axis side can be

measured at the $-\lambda/8$ position, and a vector combined signal can be formed. The rotational speed of this vector is the frequency, and therefore, in the present embodiment, this frequency and phase are analyzed.

5 [0049]

[Formula 9]

Output of detector positioned at $X_1 = 0$

$$p(f_d, 0) = A^2 \left\{ 1 + \sum_{k=1}^n \gamma_k^2 + 2 \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi(f_0 + f_d)d_k}{c} - \phi_k \right) \right\}$$

Output of director positioned at $x_2 = -\frac{\lambda}{8}$ (where $\lambda = \frac{c}{f_0}$)

$$p(f_d, -\frac{\lambda}{8}) = A^2 \left\{ 1 + \sum_{k=1}^n \gamma_k^2 - 2 \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)d_k}{c} - \phi_k \right) \right\}$$

10

[0050]

The terms a and b are given in Formula 10 below, where a is the standing-wave component of the output of the detector positioned at $x_s = 0$ in Formula 9, and b is the
 15 standing-wave component of the output of the detector positioned at $x_s = -\lambda/8$. When the third expression in Formula 8 is substituted on the basis of Formula 11 below, Formula 12 and Formula 13 below are obtained. In other words, it is possible to perform the substitution such that
 20 the X axis and the Y axis (real signal, imaginary axis signal) obtained by Formula 10 are converted to a real signal. More precisely, Formula 13 expresses a signal in the time direction and a signal on the axis of rotation, but ultimately, it is apparent that a rotating analysis signal
 25 can be calculated using Formula 13.

[0051]

[Formula 10]

$$a = \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

$$b = \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

5

[0052]

[Formula 11]

$$P_{DC} = A^2 \left(1 + \sum_{k=1}^n \gamma_k^2 \right)$$

$$m(f_d) = 2A^2 \sqrt{a^2 + b^2}$$

$$\theta(f_d) = \arctan \left(\frac{b}{a} \right)$$

$$a = \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

$$b = \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

[0053]

[Formula 12]

$$p(f_d, x_s) = P_{DC} + m(f_d) \cos \left(\theta(f_d) - \frac{4\pi(f_0 + f_d)}{c} x_s \right)$$

10

[0054]

[Formula 13]

$$\begin{aligned}
 m(f_d)e^{j\theta(f_d)} &= 2A^2(a + jb) \\
 &= 2A^2 \left\{ \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right) \right. \\
 &\quad \left. + j \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right) \right\} \\
 &= 2A^2 \sum_{k=1}^n \gamma_k e^{j \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)}
 \end{aligned}$$

[0055]

The term PDC on the right side of Formula 12 is the DC component, and $m(f_d) \cos(\theta(f_d) - 4\pi(f_0 + f_d)/c \cdot x_s)$ is the
5 standing-wave component which varies in a periodic fashion. In relation to this standing-wave component, the combined component $a + jb$ produced from the component a positioned at $x_s = 0$ and the component b positioned at $x_s = -\lambda/8$ is the orthogonal component between sin and cos, as described
10 above, and the analysis signal is a combination of a and b , whereby the effect of the unnecessary signal (the signal which has leaked in from the imaginary number side shown in FIG. 8) is removed. Accordingly, this value (the signal of Formula 13) is analyzed and the objective component $(f_d, 0)$
15 shown in FIG. 10 is thereby obtained. FIG. 12 shows the distance spectrum obtained by applying a Fourier analysis to the detection wave signal, and the fluctuation period f of the standing-wave power produced by sweeping the transmission frequency, i.e., the frequency f of the
20 distance spectrum, is represented by $c/(2d)$, as shown in FIG. 12. Accordingly, when the DC component is removed from the detected combined wave and subjected to a Fourier

transform, the frequency f can be obtained and the distance d to a person being measured can be obtained.

[0056]

In the description above, an analysis signal is a
5 combination of a component a positioned at $x_s = 0$ and a
component b positioned at $x_s = -\lambda/8$, but the present
invention is not limited thereby, and it is also possible to
measure the distance between two points set at a distance
from each other in the x -axis direction, multiply the signal
10 obtained using the real axis and the imaginary axis by a
coefficient to obtain a combined signal by calculation. The
power level detected by the two detectors is manifest as the
real-axis component (I component) and the imaginary-axis
component (Q component), and each are an orthogonal
15 component of a sin waveform and a cos waveform, as shown in
FIG. 13. At this point, when the detection position of the
reflected wave is set at a distance of $\lambda/8$ away in the x -
axis direction, the phase Φ is 45° and the signals obtained
on the real axis and the imaginary axis are in a 1:1
20 relationship. Therefore, it is possible to dispense with a
coefficient and perform the analysis directly. However,
when the distance between the two points is, e.g., $\lambda/6$, the
phase is 60° , and the distance can be analyzed using a
coefficient with the real axis (x axis) and the imaginary
25 axis (y axis) in a 1:2 relationship (the imaginary axis
being double the real axis). Accordingly, computation is
not necessarily limited to the case in which a reflected
wave is detected at two points set at a distance of $\lambda/8$ from

each other, but there is an advantage in that computation processing is simplified by detecting a reflected wave at two points set at a distance of $\lambda/8$ from each other.

[0057]

5 The distance spectrum when there are two targets is obtained by removing the DC portion from a combined wave of the power $p(f_d, 0)$ at $x_s = 0$ and the power $p(f_d, -\lambda/8)$ at $x_s = -\lambda/8$ and performing a Fourier transform, thereby obtaining a frequency corresponding to the distance and
10 obtaining the distances d_1 and d_2 , as shown in FIG. 11.

[0058]

FIG. 12 represents the anti-logarithm spectrum and the imaginary-number spectrum of a combined wave. The speed of radio waves c is about 300,000 km per second. When a
15 frequency sweep of an emitted wave is carried out with a width of 75 MHz (fw), the wavelength at 75 MHz is $c/fw = 4m$. However, in a sweep for sampling the waveform, the round trip is 4 m, so the outgoing distance is therefore half at 2 m. This 2 m unit is referred to as a single period. In
20 view of the above, 10 periods are measured when 20 m are measured in a sweep width of 75 MHz. When the sweep time is 256 μs , the frequency of the observed waveform is $10/256 \mu s = 39$ kHz. Similarly, when 200 m are measured, there are 100 periods, and therefore $100/256 \mu s = 390$ kHz. The level of
25 the frequency in the detected spectrum shown in FIG. 12 shows the strength of the reflection, and the frequency can be substituted for distance. Accordingly, as shown in FIG. 11, when a peak is manifest at 39 kHz by Fourier transform,

it is apparent that wave is a reflected wave from a position at a distance $d_1 = 10$ m, and when a peak is manifest at 390 kHz, it is apparent that wave is a reflected wave from a position at a distance $d_2 = 100$ m. In this manner, when the
5 detection power $p_a(f_d)$ of the combined wave in the detector is integrated, the DC component is removed, and a Fourier transform is performed, the distance to a reflection object can be obtained.

[0059]

10 When the sweep width is 200 MHz, a single period is 0.75 m. Therefore, when the measurement is 10 m, $10/0.75 = 13.3$ periods are observed, and when the sweep time is 256 μ s, $13.3/256 = 51.9$ kHz. In other words, when the sweep width is 200 MHz and a peak is manifest at 51.9 kHz, the
15 distance to the reflection object is observed to be 10 m. Therefore, the sweep width and the sweep time are adjusted, whereby the frequency of the detection wave output can be adjusted. Since the bandwidth is limited by restrictions in the Radio Wave law, the distance to the reflection object is
20 generally measured by varying the sweep time.

[0060]

Next, measurement of very small displacements will be described. In relation to the phase, in Formula 8, the phase related to a k th target is obtained by Formula 14
25 below, where dk is the amount of change in the distance dk , and $\Delta\phi_k$ is the amount of change in phase, resulting in Formula 15 below.

[0061]

[Formula 14]

$$b = \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right) \longrightarrow \psi_{Ak} = \frac{4\pi f_A}{c} d_k$$

[0062]

[Formula 15]

$$d_k = \frac{c}{4\pi f_0} \Delta\psi_k$$

5

[0063]

A very small displacement in the distance d is obtained from Formula 15. When the frequency is 24 GHz, it is possible to sense a displacement of ± 3.125 mm.

10

[0064]

As described above, the distance and very small displacements of a reflection object can be measured in the signal processor 42 by analyzing a standing wave obtained by combining a reflected wave from the reflection object with the transmitted wave. Chronologically ascertaining the measurement results makes it possible to measure the distance, speed, and displacement of the reflection object, and as a result, the movement of the reflection object. In conventional radar, it is difficult to measure a distance of 1 to 2 m or less, but the present invention makes it possible to measure the distances from nearly 0 m to as far as 200 m. In the case of the present invention, sensing very small displacements is possible, and the relative displacement resolution is as high as 0.01 mm. Furthermore, in the case of a standing-wave radar, abnormalities of the

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human body can be sensed with high precision because waves pass through clothing and are directly reflected by a clothed human body.

[0065]

5 Next, another embodiment of the present invention will be described with reference to FIG. 14. The present embodiment senses respiratory rate, heart rate, and other biological information on the basis of Formula 15 above from an analysis signal containing biological information, and
10 the distance to a person to be measured is also sensed. FIG. 14 is a diagram showing the frequency sweep signal (detected wave signal on the real axis and imaginary axis) of the present embodiment. When the center frequency f_0 of the emitted wave is, e.g., 24 GHz and the sweep frequency is
15 75 MHz (fw), analysis is performed in the interval of a single period (75 MHz) with the standing wave being divided into a first-half interval and a second-half interval. In other words, analysis is carried out by Fourier transform and the phases Φ_1 and Φ_2 in the vector plane of the
20 analysis signal of b1 and b2 are represented by Formula 16 and 17 below in similar fashion to Formula 14 above, where b1 is the analysis signal obtained when the oscillator VCO has been varied from a frequency f_0 to $f_0 + f_{d1}$ (the first-half interval of a single period), and b2 is the analysis
25 signal obtained when the VCO has been varied from a frequency $f_0 + f_{d1}$ to $f_0 + f_d$ (the second-half interval of a single period). Accordingly, the phase difference $\Delta\Phi$ is obtained by subtracting Formula 16 from Formula 17, giving

Formula 18 below. This is shown in FIG. 15, where $2\pi/3$ is the phase difference. This phase difference $\Delta\Phi$ is in a range of 0 to 2π . This phase difference is the phase difference $\Delta\Phi$ of the analysis signal and is not the change in phase ($\Delta\Phi_k$ of Formula 15), as shown in FIG. 16.

[0066]

[Formula 16]

$$\Phi_1 = \frac{4\pi(f_0 + f_{d1})}{c} dk - \theta_k$$

[0067]

[Formula 17]

$$\Phi_2 = \frac{4\pi(f_0 + f_d)}{c} dk - \theta_k$$

[0068]

[Formula 18]

$$\Delta\Phi = \Phi_2 - \Phi_1 = \frac{4\pi(f_d - f_{d1})}{c} dk$$

[0069]

When dk is isolated in Formula 18, Formula 19 below is obtained.

[0070]

[Formula 19]

$$dk = \frac{c}{4\pi(f_d - f_{d1})} \Delta\Phi$$

[0071]

By Formula 18, since the speed of light $c = 3 \times 10^8$ (m/sec), the distance dk is calculated to be $dk = 3 \times 10^8 \times$

$(2\pi/3)/4\pi (150 \times 10^6 - 100 \times 10^6) = 1.0$ m for the case in which the phase difference $\Delta\Phi$ is $2\pi/3$ (120°), where $f_d = 150$ MHz and $f_{d1} = 100$ MHz. The measurement range is 0 to 2π , and it is therefore possible to measure distance of 1.0 m to a tripled value at 3 m. In this manner, the physiological state such as the respiratory rate and pulse obtained by very small displacements, as well as the distance d can be obtained from the phase difference.

[0072]

10 Next, usage examples of the standing-wave radar-integrated LED illumination apparatus according to embodiments of the present invention installed will be described. FIG. 17 is the case in which the LED illumination apparatus of the present embodiment is installed in the ceiling of a restroom to monitor human body abnormalities. FIG. 18 is the case in which the LED illumination apparatus of the present embodiment is installed in the ceiling of a bathing room to monitor human body abnormalities. FIG. 19 is the case in which the LED illumination apparatus of the present embodiment is installed in the ceiling of a hallway to monitor human body abnormalities.

[0073]

25 First, the case in which a resident has fallen in a restroom will be described, as shown in FIG. 17. First, the LED illumination apparatus is installed and a standing wave without the presence of a person is analyzed to thereby measure the distance d_4 to the floor surface and the

distance d3 to the toilet from the LED illumination apparatus. A resident then enters the restroom, and the distance d2 is measured by the LED illumination apparatus of the present embodiment. The distance d2 is the distance to
5 the head of the resident. At this time, the LED illumination apparatus may be turned on. In this manner, the distance d2, which is different from d3 and d4, is measured, and it is thereby determined that a resident is using the restroom. After a length of time suitable for
10 usage of the restroom has elapsed and when the distance d2 is no longer measured, it is determined that the restroom has been used in an ordinary manner. When observation of the distance d2 has ended, the LED illumination apparatus may be turned off.

15 [0074]

On the other hand, when a user is curled up in the restroom and when seated on the floor, an abnormality has occurred in the human body, the distance d5 and the distance d6 are different than the distances d3 and d4 and are
20 greater than the distance d2 to the head when seated on the toilet. It is therefore apparent that an abnormal state has arisen. In this case, if the user is conscious, the LED illumination apparatus detects the movement of the user, it is determined that the object is a human body rather than an
25 article, and the occurrence of an abnormality in the human body can be reliably ascertained. The alarm unit 43 thereby outputs an alarm signal to provide external notification about the abnormal situation of a restroom user. At the

same time, it is also possible to display the dangerous state by causing the LED illumination apparatus to blink on and off, causing the amount of light to vary using light modulation, or varying the color temperature (hue). When a portion of the restroom door is translucent glass, a danger display using the above-described LED illumination apparatus is provided as notification to a family member or the like outside the restroom.

[0075]

When a user has collapsed on the restroom floor and is not conscious, the LED illumination apparatus measures a distance d_7 that is different from the distance d_2 to the head, and movement of the human body cannot be measured. However, in the present invention, very small displacements can be detected by phase analysis, and the respiratory rate, pulse, and other very small displacements in the human body of the collapsed person can also be detected. In view of the above, the present invention is capable determining that an object is not an article, but is rather a human body that has collapsed. In this case, the standing-wave radar can pass through clothing and directly measure movement on the surface of the human body, and it is therefore possible to more reliably sense an abnormality of the human body. An organism is a reflection object having a reflection coefficient of 0.7 or higher, and it is therefore possible to measure displacement using the surface of the human body and to directly measure skin movement of the human body through clothing. The displacement amplitude of the

breathing of an ordinary adult is generally about 2 to 3 mm, and the very small displacement of a standing wave can be measured to about ± 3 mm. Therefore, abnormality of a human body can be reliably sensed. Also, when the respiratory
5 rate, pulse, or other danger area or rhythmic pattern is set in advance in the computation unit 31, it is possible to not only differentiate between a human body and an article by detecting respiration or the like, but it is also possible to determine whether or not the respiratory state of the
10 human body is serious.

[0076]

In the case of the bathing room shown in FIG. 18, in the case of a hallway shown in FIG. 19, or in other cases, measurement results are similarly obtained for when a person
15 is not present, and the abnormality of a resident can be determined by excluding the measured distance from the abnormality sensing. At this time, the distance range to be detected during ordinary human body movement is set, and it can be determined that an abnormality has occurred in a
20 resident when a distance outside of this range has been detected. Furthermore, since the respiration and pulse can be measured from very small displacements, it is possible to determine whether an object is a human body, and, if the object is a human body, to what degree the situation is
25 serious. FIG. 20 is a chart showing the state of measuring a respiratory rate. It is apparent that abnormal respiration can be detected by the present invention, as shown in FIG. 20.

[0077]

FIG. 21 shows a method for mounting the LED illumination apparatus of an embodiment of the present invention in the ceiling of a train, and analyzing standing
5 waves to determine the level of congestion on a train. Mounting the LED illumination apparatus of an embodiment of the present invention in the ceiling of a train in this manner makes it possible to detect whether the number of human bodies on a train is high or low and to determine the
10 general number thereof. Therefore, a central operations and management center for trains can readily ascertain whether the train is full, congested in an ordinary fashion, or not congested.

[0078]

15 FIG. 22 shows a method for mounting the LED illumination apparatus of an embodiment of the present invention in an urban utility pole to provide LED illumination and to determine the water level when a road has been flooded with water and to determine the extent that
20 people are present in the road undergoing this abnormality. In this manner, mounting the LED illumination apparatus of an embodiment of the present invention in a utility pole makes it possible for a disaster prevention center to manage and determine changes in the water level of the road flooded
25 with water, to determine the number of people that have been dispatched to the road in such a case, and to make other determinations.

[0079]

The present invention is not limited to the embodiments described above and can be modified in various ways. For example, FIG. 23 shows another mode of the illumination apparatus of the present invention. The illumination apparatus shown in FIG. 23 is different from the light bulb-type shown in FIG. 2, has LEDs arranged on the obverse side of a sign or other planar light-emitting display surface, and is a directly under-type illumination light. A transceiver 102 for transmitting a radio wave to the exterior and receiving a reflected wave from the exterior is installed in the center position on a board 100. A plurality of LEDs 101 is arranged at, e.g., equidistant intervals about the periphery of the transceiver 102. These LEDs 101 and transceiver 102 are covered by a transparent cover 103. The illumination light from the LEDs 101 is emitted to the exterior via the cover 103, and the transceiver 102 transmits/receives the transmitted wave and the reflected wave via the cover 103. This cover 103 has a light-scattering effect, and LED illumination light scattered from the cover 103 toward the exterior is emitted as smooth illumination light. In this illumination apparatus as well, radio waves can be transmitted from and reflected waves received by the transceiver 102. In this directly under scheme, the LEDs are arranged behind the illumination cover, and LED light is emitted direction to the exterior. Accordingly, the luminous energy of the LED light is high, and the transceiver 102 cannot be disposed behind (below) the metal heat-dissipating board 101, and the

installation position of the radar transceiver is restricted. It is apparent that the display surface for planar light emission is not necessarily limited to a sign. A surface such as wall that does not have characters or
5 drawings thereon may also be used in the same manner a sign.

[0080]

The illumination apparatus shown in FIG. 24 is a light guide scheme illumination apparatus. A radio wave transceiver 112 is arranged behind a light guide plate 110,
10 illumination light emitted from a plurality of LEDs 111 lined up at equidistant intervals is introduced into the light guide plate 110 from the side surface of the light guide plate 110. The illumination light is reflected inside the light guide plate 110 and irradiated from the light
15 guide plate 110 in a direction perpendicular to the surface thereof. A transparent cover 113 is also arranged in front of the light guide plate 110 and the cover 113 also has a light-scattering effect and is capable of irradiating smooth illumination light by scattering. LED light that has
20 entered into the light guide plate 110 is reflected onto the upper and lower surfaces inside the light guide plate 110, the luminous energy forms a substantially uniform plane emission light within the surface, and is emitted to the exterior from the upper surface of the light guide plate
25 110. In this illumination apparatus as well, a radio wave can be transmitted and a reflected wave can be received from the transceiver 112. In this light guide scheme, the illumination light can be emitted in a planar form, and the

position of the radar transceiver 112 may be behind the light guide plate 110 and the installation location is not restricted.

[0081]

5 FIG. 25 is a chart showing measurements of the respiratory state of a person 201 lying on a bed 202, as shown in FIG. 26, in the form of very small displacements obtained from the amount of phase change in a distance spectrum using the LED-integrated standing-wave radar 200 of
10 the present embodiment disposed in a ceiling. In the case as well of a person lying on a bed, obtaining measurement results of the distance spectrum when a person is not present and eliminating noise produced by the measurement of the bed and other accessory articles makes it possible to
15 determine whether a person is on the bed, and the present invention can be used as a bed-leaving sensor. In this case, the present invention is capable of measuring respiration and pulse from very small displacements, and it is therefore possible to reliably determine whether a
20 measured object is a human body.

[0082]

On the other hand, the lungs swell when air is inhaled (during inhalation), and the lungs contract with when air is exhaled (during exhalation). In view of this fact, when a
25 time A from a stationary state to a peak value (during inhalation; lungs in swelled state) when air has been inhaled is measured, and a time B from a stationary state to when air is expelled (during exhalation) is measured, then A

+ B is a respiratory period. In other words, the vertical movement of the lungs of a person 201 is sensed by the standing-wave radar 200 of the present embodiment. In the present embodiment, vertical movement of the chest by
5 respiration of the person 201 can be sensed by the standing-wave radar 200 even when the person 201 is wearing clothing or when the person 201 is covered by bedding. The chart on the right in FIG. 26 shows chronological change in the respiratory rate and respiratory stability of a person 201
10 on the bed 202 measured by the standing-wave radar 200 of the present embodiment. FIG. 26 also shows the results of separately measured blood pressure and body temperature. In FIG. 26, respiratory stability is related to the magnitude of vertical movement in the respiratory period A + B shown
15 in FIG. 25. In other words, the wave shown in FIG. 25 is larger when the vertical movement of the chest by respiration is great. The magnitude of the vertical movement of the chest increases and decreases, and when the frequency of change in magnitude is high, respiratory
20 stability is considered to be poor. In FIG. 26, the case in which frequency of change in the magnitude of vertical movement of the chest is low is the upper part of the vertical axis of the graph, and respiratory stability is considered to be high; and the case in which frequency of
25 change in the magnitude of vertical movement of the chest is high is the upper part of the vertical axis of the graph. As shown in FIG. 26, the respiratory stability of the person 201 has worsened (trended lower) after two months had

elapsed, and it is apparent that respiratory disturbance increased and indications of cardiac failure have appeared. Nevertheless, change in the blood pressure and body temperature are not observed, and no change in the
5 respiratory rate is observed. Accordingly, indications of cardiac failure cannot be sensed by merely monitoring the blood pressure, body temperature, and respiratory rate.

[0083]

It is well known that heart action is competitively
10 controlled by sympathetic nerves and parasympathetic nerves, and that the heart beat interval constantly fluctuates in periodic fashion. Here, two main frequency components are observed when fluctuation information about the heart beat interval (hereinafter referred to as "heart beat fluctuation
15 information") generated from chronological heart beat interval information is subjected to a frequency analysis. One of the components is a frequency component of 0.05 to 0.15 Hz, which is referred to as a low-frequency (LF) component, and mainly reflects the state of activity of
20 sympathetic nerves and parasympathetic nerves. The other component is a frequency component of 0.15 to 0.45 Hz, which is referred to as a high-frequency (HF) component, and mainly reflects the state of activity of parasympathetic nerves. Since these frequency components reflect autonomous
25 nervous activity, the power of the spectrum thereof is used as an indicator of the state of activity of automatic nerves in tests of automatic nervous function or the like. In a state of rapid eye movement sleep (REM), the voluntary

muscles of the body show a state approximate to an awakened brain, even in a relaxed state, and the eyes move often under the eyelids. Non-REM sleep is a state of sound sleep. The first REM sleep appears at about 60 to 120 minutes after
5 the start of sleep, and REM sleep thereafter appears in a repeating fashion between REM sleep and non-REM sleep. The period is generally 90 minutes (90 to 110 minutes), and about three to five periods occur during sleep. In this case, it is known that light sleeping during REM sleep is
10 easier to awaken from than is deep sleep during non-REM sleep. Sleep is considered to be one biological periodic phenomenon (circadian rhythm: a rhythm with a period of about 24 hours) and is controlled by nerve tissue referred to as an internal biological clock.

15 [0084]

In the embodiments of the present invention, fluctuation information about heart beat intervals is subjected to a frequency analysis, whereby the time interval, number of cycles, and the like of non-REM sleep
20 and REM sleep can be detected. In view of the above, it is possible to use the device for detecting human body abnormality using standing-wave radar of the present embodiment to sense abnormalities in the sleep state using the heart rate. Also, in accordance with the LED-integrated
25 standing-wave radar of the present embodiment, it is possible to know the timing of non-REM sleep and REM sleep from the heart rate. Therefore, the color temperature of the LEDs can be set to be a red, low color temperature when

sleep is being induced prior to going to bed, and the color temperature of the LEDs can be set to be a blue, high color temperature when an awakened state must be induced. The illumination light is thereby modified with suitable timing, whereby an awakened state and a sleep state can be suitably supported, making it possible to contribute to the maintenance of a state of mental health.

INDUSTRIAL APPLICABILITY

[0085]

In accordance with the present invention, it is possible to sense a person that has collapsed or the like, and the respiratory rate, pulse, and other physiological information of a human body, and it is possible to sense that a human body has fallen into a dangerous state, making a tremendous contribution to securing the safety of a human body.

Key

[0086]

- 1: metal cap
- 2: case main body
- 3: cover
- 5: aluminum board
- 6: LED
- 7: standing-wave radar module board
- 8: standing-wave radar module
- 10: LED control unit
- 11: board
- 12: frame

31: computation unit

35: 24-GHz high-frequency module

42: signal processor

What is claimed Is:

1. A device for sensing human body abnormality using standing-wave radar, comprising:

5 a standing-wave sensor for externally transmitting a frequency-swept radio wave, detecting, at two points separated by a fixed distance, a reflected wave received from an external reflection object based on the transmitted wavelength with λ being the wavelength of the transmitted wave, and sensing a standing wave combined from the
10 transmitted wave and the received wave;

a computation unit for removing the DC component from the intensity distribution of the frequency of the combined wave sensed by said standing-wave sensor, performing a Fourier transform, obtaining a distance spectrum, and
15 computing a change in phase and distance to said reflection object;

a signal processor for removing the distance component obtained when no person is present in a measurement space from the distance component to the obtained reflection
20 object, and obtaining distance information that is different from the distance component obtained when no person is present in the measurement space to extract the distance component to a person to be measured who has entered into said measurement space; and

25 a determination unit for sensing an abnormality in a person to be measured from a variation in the intensity distribution of the component associated with the distance to the person to be measured and determining the physical

state of said person to be measured and the physiological state including a respiratory rate and pulse from said change in phase.

2. A device for sensing human body abnormality using
5 standing-wave radar, comprising:

a standing-wave sensor for externally transmitting a frequency-swept radio wave, detecting, at two points separated by a fixed distance, a reflected wave received from an external reflection object based on the transmitted
10 wavelength with λ being the wavelength of the transmitted wave, and sensing a standing wave combined from the transmitted wave and the received wave;

a computation unit for removing the DC component from the intensity distribution of the frequency of the combined
15 wave sensed by said standing-wave sensor, performing a Fourier transform, obtaining a distance spectrum, and computing from the distance spectrum of a first interval and the distance spectrum of a second interval in a single period a phase difference from the distance spectra and a
20 change in phase;

a signal processor for removing the distance component obtained when no person is present in a measurement space from the distance component to the reflection object obtained from said phase difference, and obtaining distance
25 information that is different from the distance component obtained when no person is present in the measurement space to extract the distance component to a person to be measured who has entered into said measurement space; and

a determination unit for sensing an abnormality in a person to be measured from a variation in the intensity distribution of the component associated with the distance to the person to be measured and determining the physical state of said person to be measured and the physiological state including a respiratory rate and pulse from said change in phase.

3. The device for sensing human body abnormality using standing-wave radar according to claim 1 or 2, comprising:

a case at least partially provided with a transparent cover; and

a LED light source as a light-emitting unit for irradiating illumination light to the exterior via said cover, the LED light source being housed in the case,

said standing-wave sensor, said computation unit, said signal processor, and said determination unit being housed in said case, and said standing-wave sensor transmitting/receiving radio waves via said cover and being housed in an LED illumination apparatus.

4. The device for sensing human body abnormality using standing-wave radar according to claim 3, wherein a power supply unit comprising a connector that can be mounted in a light bulb socket or sealing is disposed below said case, and power is supplied to said LED light source and said standing-wave sensor via the power supply unit.

5. The device for sensing human body abnormality using standing-wave radar according to claim 3 or 4, wherein said computation unit, said signal processor, and said

determination unit are housed in said case as a module together with said standing-wave sensor.

6. The device for sensing human body abnormality using standing-wave radar according to any of claims 1 to 5,
5 wherein said determination unit transmits an alarm signal to an external alarm signal receiver when the distance to said person to be measured, or the respiratory rate or pulse of said person to be measured has been determined to be in a danger area set in advance.

10 7. The device for sensing human body abnormality using standing-wave radar according to any of claims 3 to 5, wherein said determination unit emits an alarm by turning said LED illumination apparatus on and off, or varying the light modulation, when the distance to said person to be
15 measured, or the respiratory rate or pulse of said person to be measured has been determined to be in a danger area set in advance.

8. A method for using a device for sensing human body abnormality using standing-wave radar, wherein the device
20 for sensing human body abnormality using standing-wave radar according to any of claims 1 to 7 is installed in a ceiling of a building or residence to determine an abnormality of a human body inside the residence or building.

9. A method for using a device for sensing human body
25 abnormality using standing-wave radar, wherein the device for sensing human body abnormality using standing-wave radar according to any of claims 1 to 7 is installed in a ceiling of a vehicle or a ceiling of passage or tunnel to determine

congestion of human bodies therein.

10. A method for using a device for sensing human body abnormality using standing-wave radar, wherein the device for sensing human body abnormality implemented by the
5 standing-wave radar-integrated LED illumination apparatus according to any of claims 3 to 5 is installed for illuminating a road using said LED light source, and a water level of water that has flooded the road and congestion of human bodies positioned in the road are determined.

ABSTRACT

LEDs arranged in a circle, a standing-wave laser module, a board with a computation unit provided thereon, and an LED control unit are disposed inside a case.

5 Illumination light is irradiated outward from the LEDs, and microwaves are transmitted from the standing-wave laser module and the reflected waves are detected. The computation unit combines the transmitted waves and the reflected waves to detect standing waves, and the distance
10 to the body off which the waves are reflected and minute displacements (e.g., pulse and respiration) are detected on the basis of the standing waves. Thus, merely installing the present invention in lieu of existing illumination apparatuses installed in restrooms, bathing rooms,
15 corridors, and the like allows the position of a human body, and the respiratory rate, heart rate, and the like thereof to be detected, and allows sudden changes to the condition of the detected human body to be rapidly detected.

FIG. 1

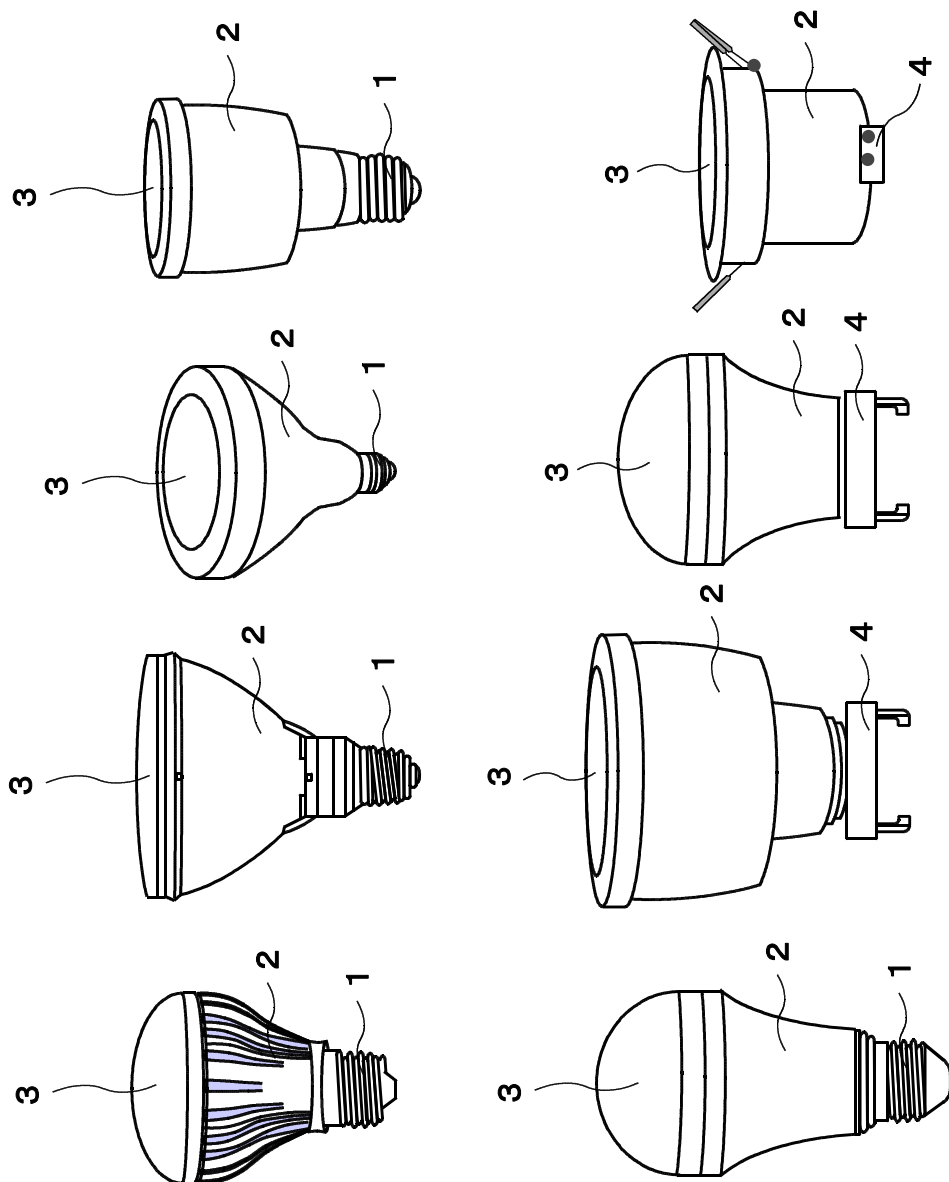
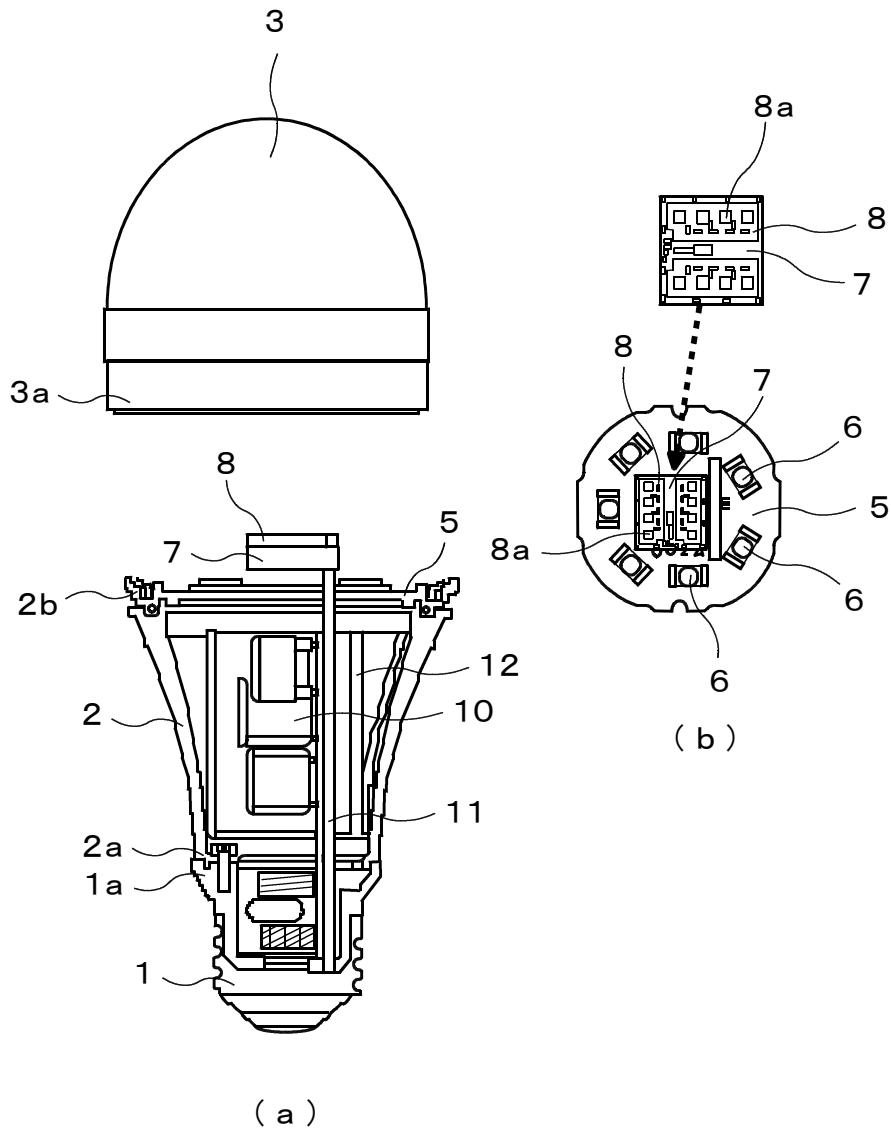


FIG. 2



7

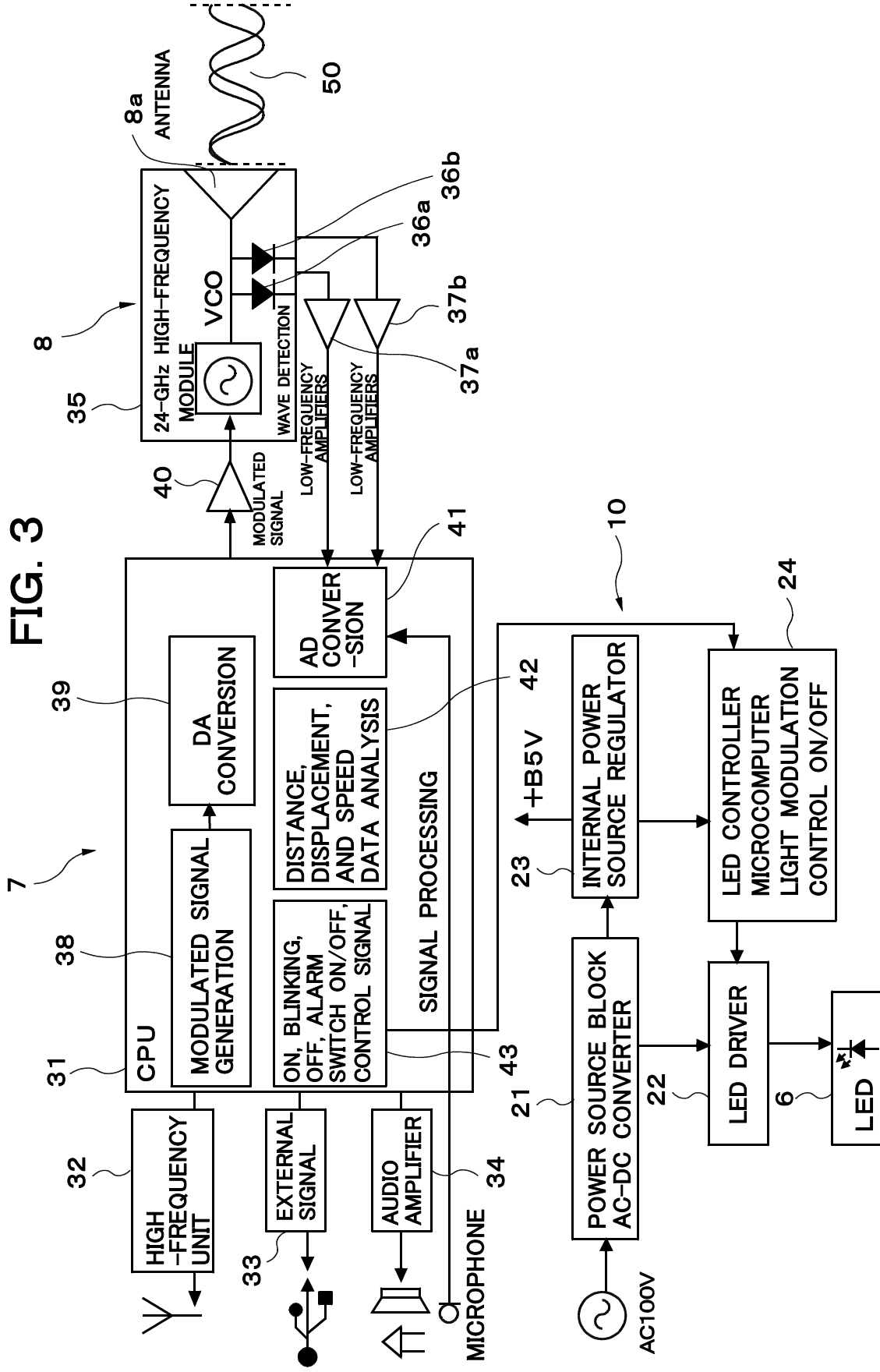


FIG. 4

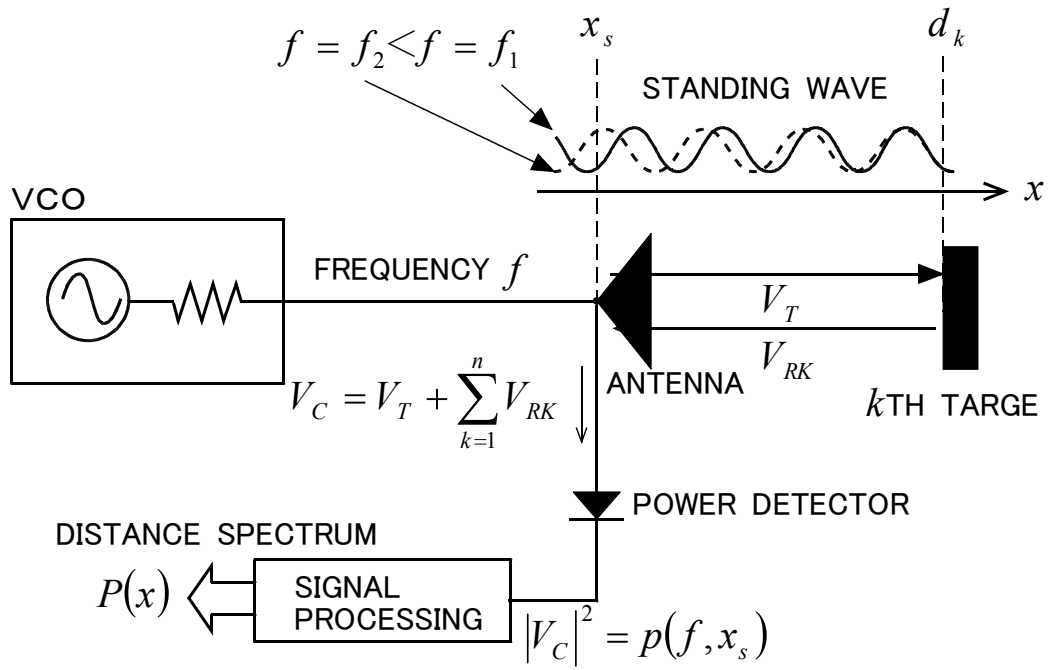
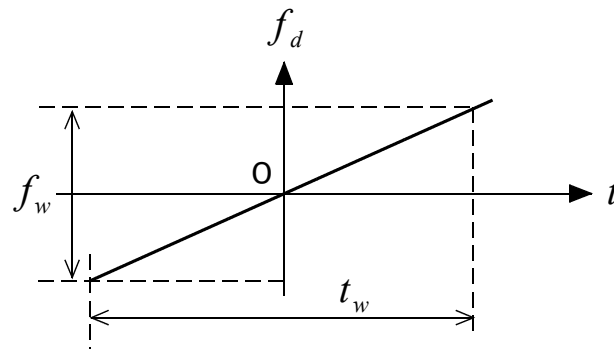


FIG. 5

A: AMPLITUDE OF THE SIGNAL SOURCE

c: SPEED OF LIGHT

f: FREQUENCY $\left\{ \begin{array}{l} f(t) = f_o + f_d \\ f_d = \frac{f_w}{t_w} t \end{array} \right.$



FREQUENCY VARIES IN A STEPWISE FASHION FROM
 $f = f_o - f_w / 2$ TO $f = f_o + f_w / 2$

FIG. 6

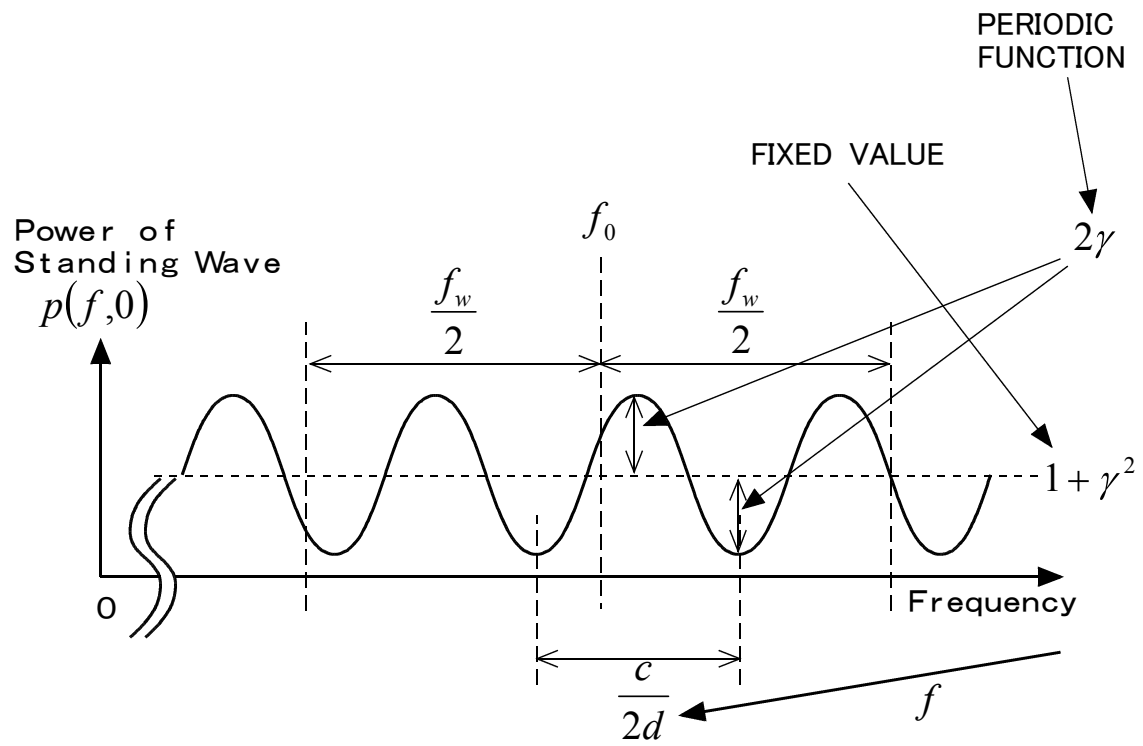


FIG. 7

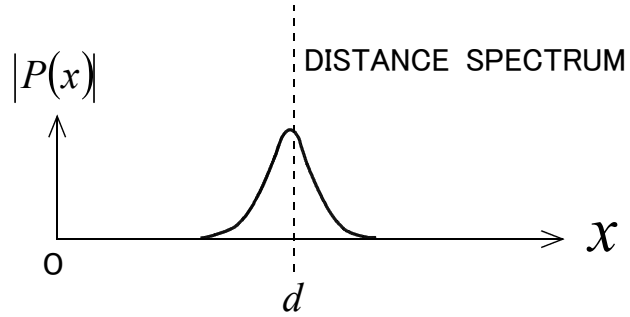


FIG. 8

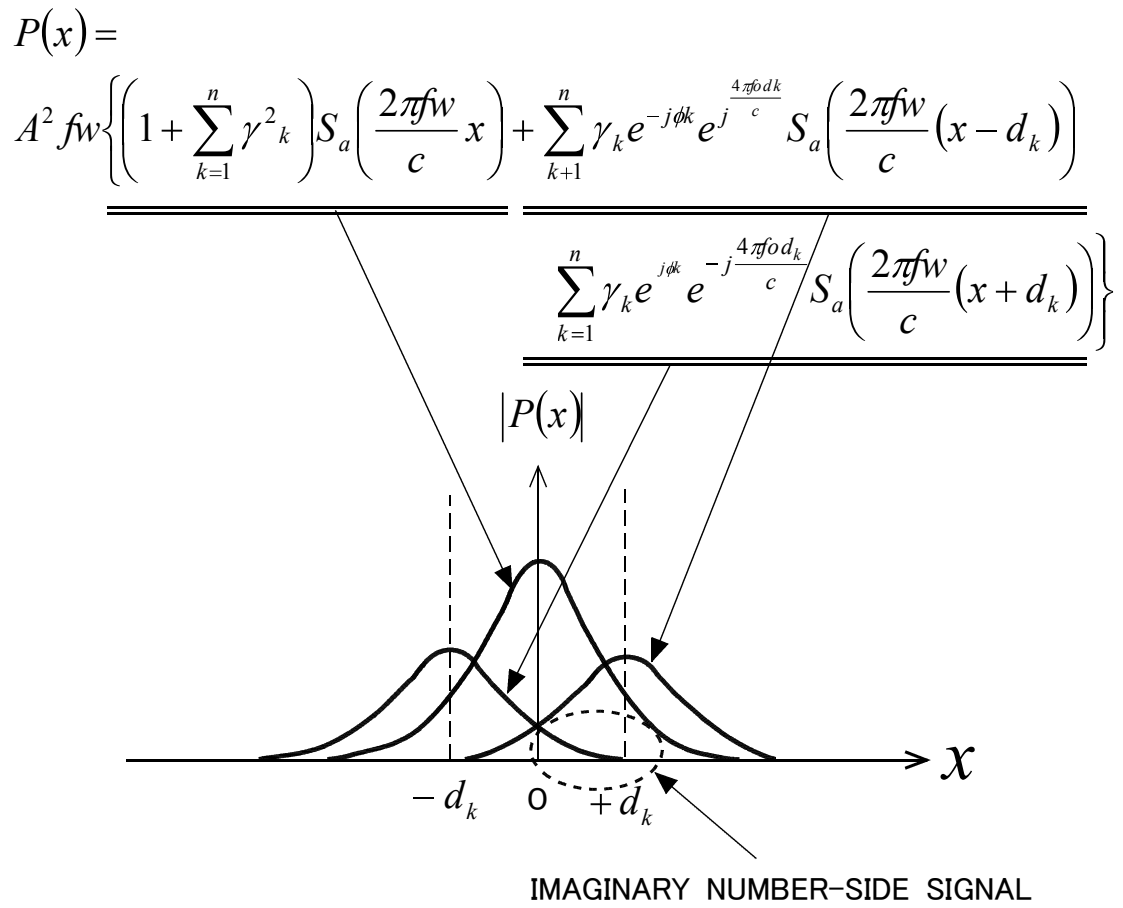


FIG. 9

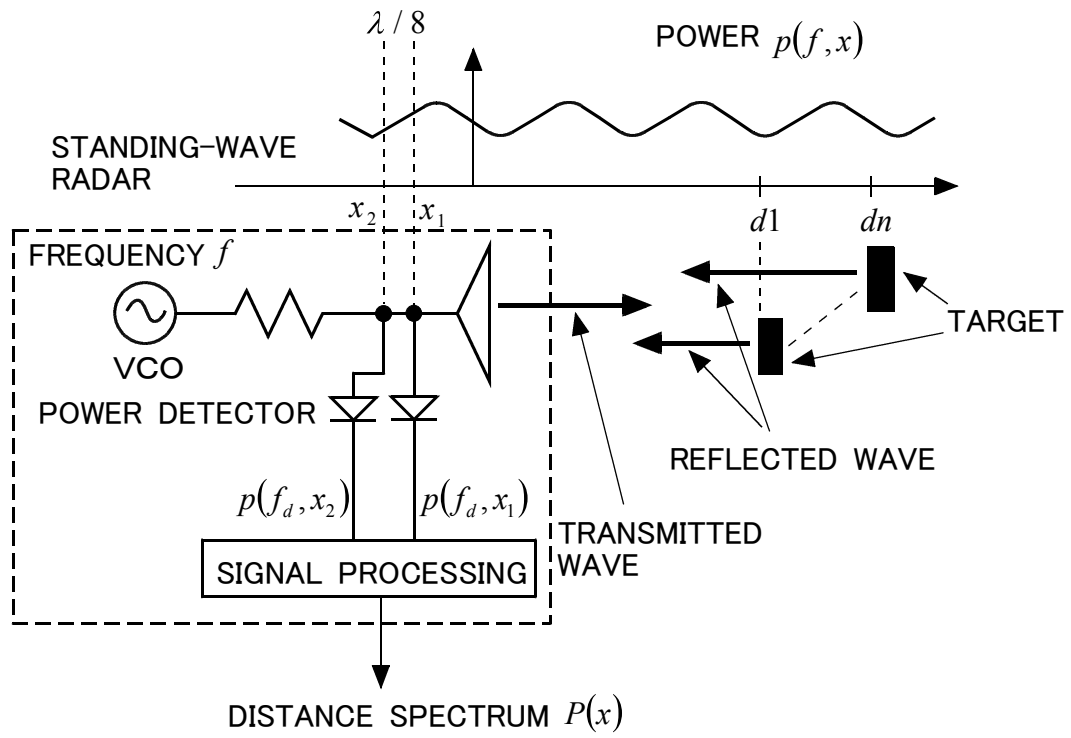


FIG. 10

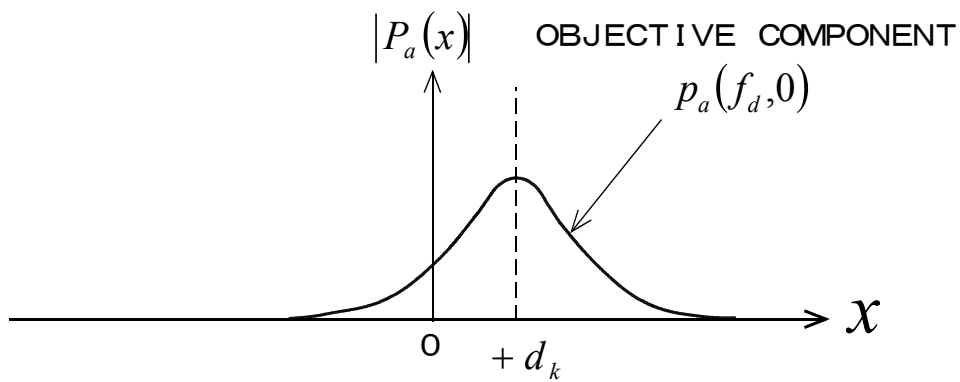


FIG. 11

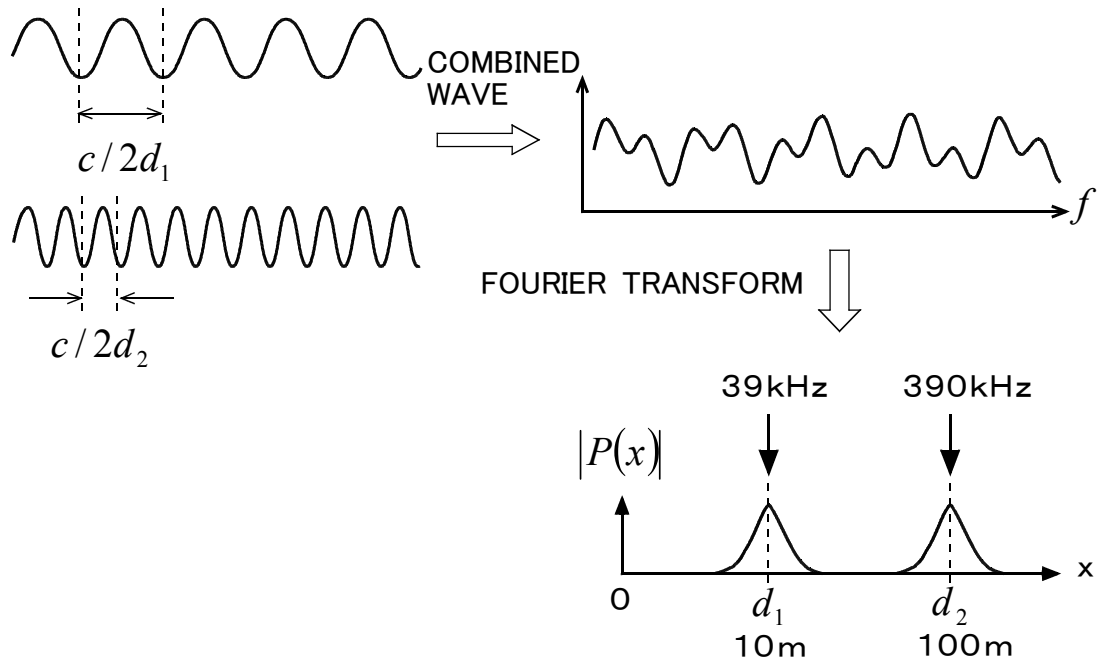


FIG. 12

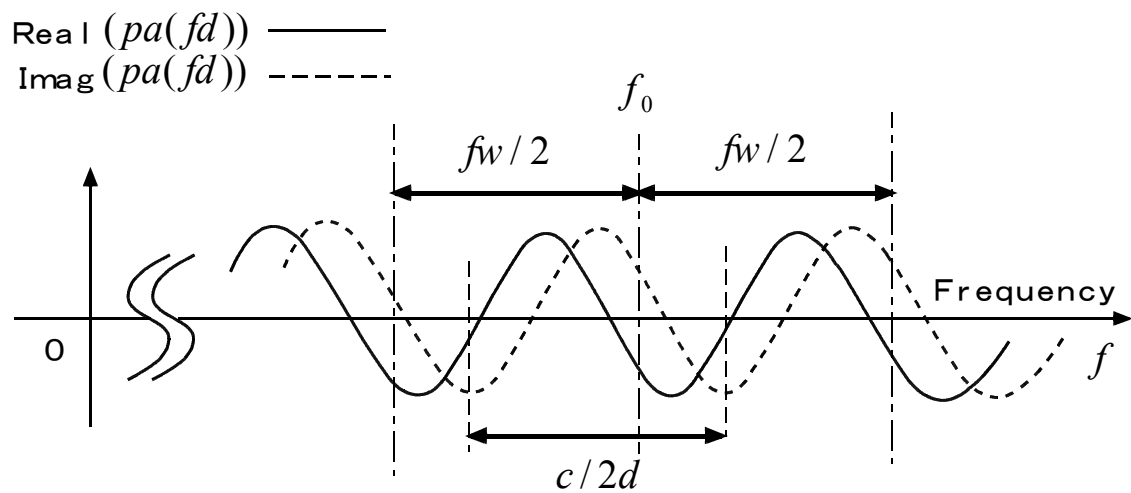


FIG. 13

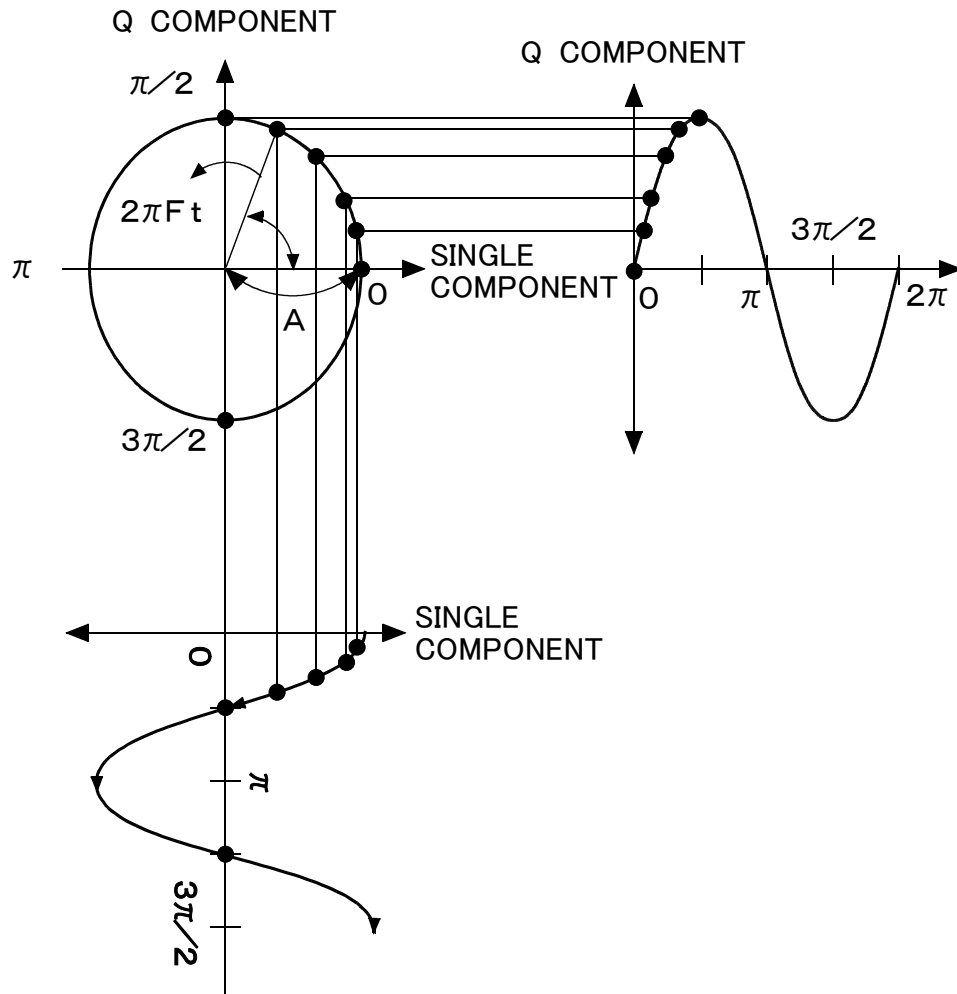
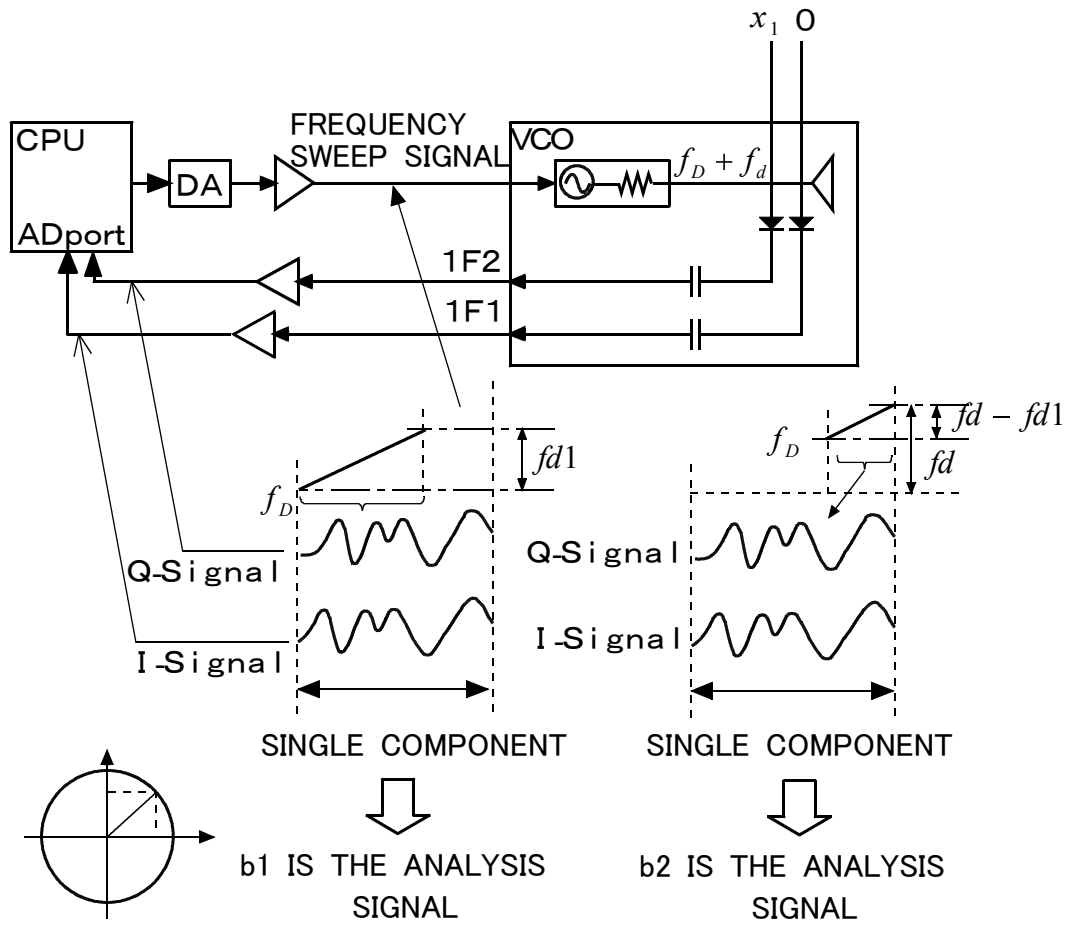


FIG. 14



$$\text{AMPLITUDE} = \sqrt{I^2 + Q^2} \frac{4\pi(f_0 + fd1)}{c} dk - \theta_k$$

$$\text{PHASE } \Phi = \tan^{-1} \frac{Q}{I}$$

$$\frac{4\pi(f_0 + fd)}{c} dk - \theta_k$$

FIG. 15

$$\Delta\Phi = \frac{4\pi(fd + fd1)}{c} dk$$

$$dk = \frac{c}{4\pi(fd - fd1)} \Delta\Phi$$

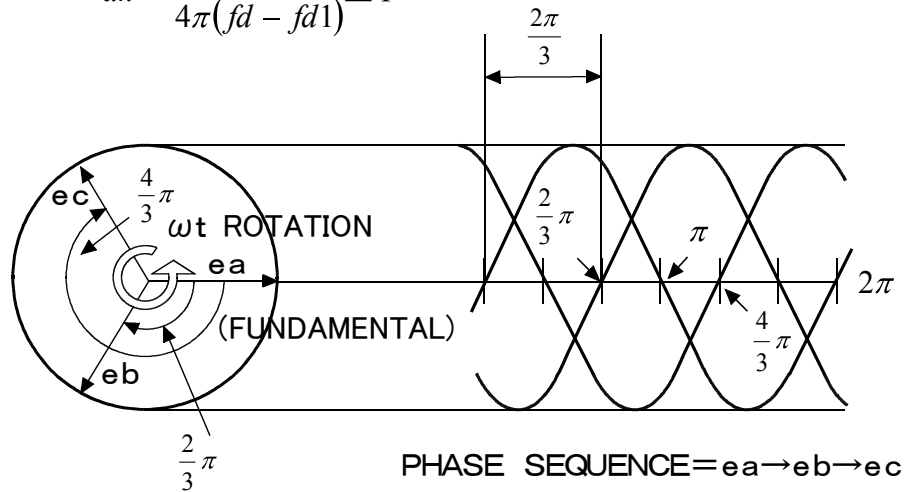


FIG. 16

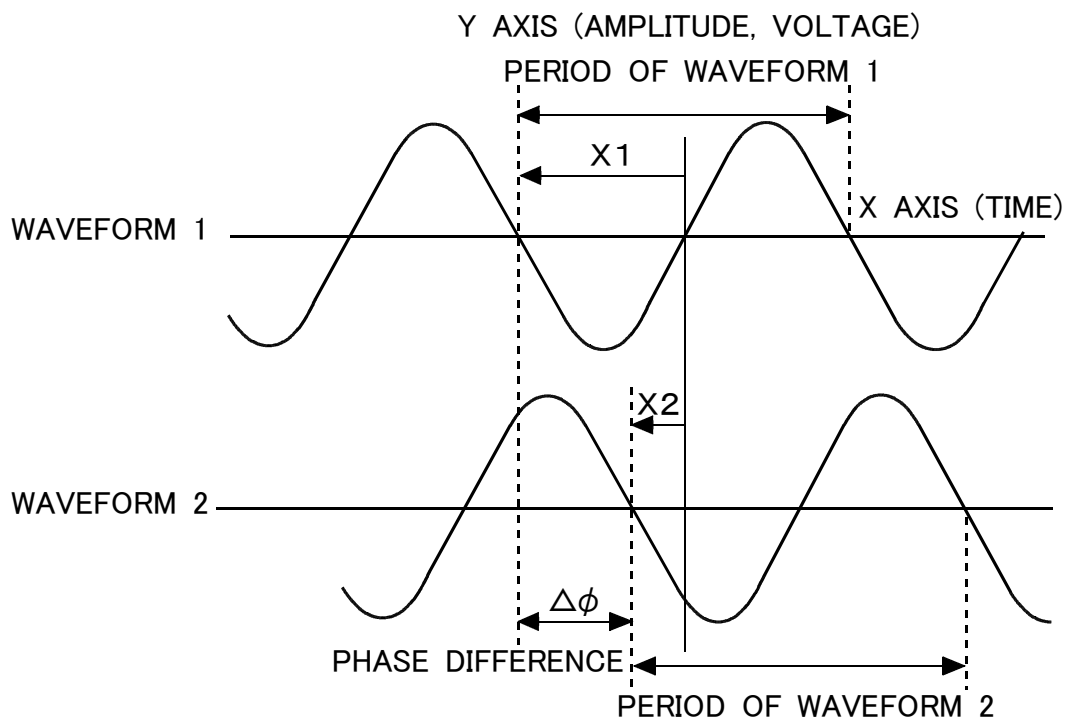


FIG. 17

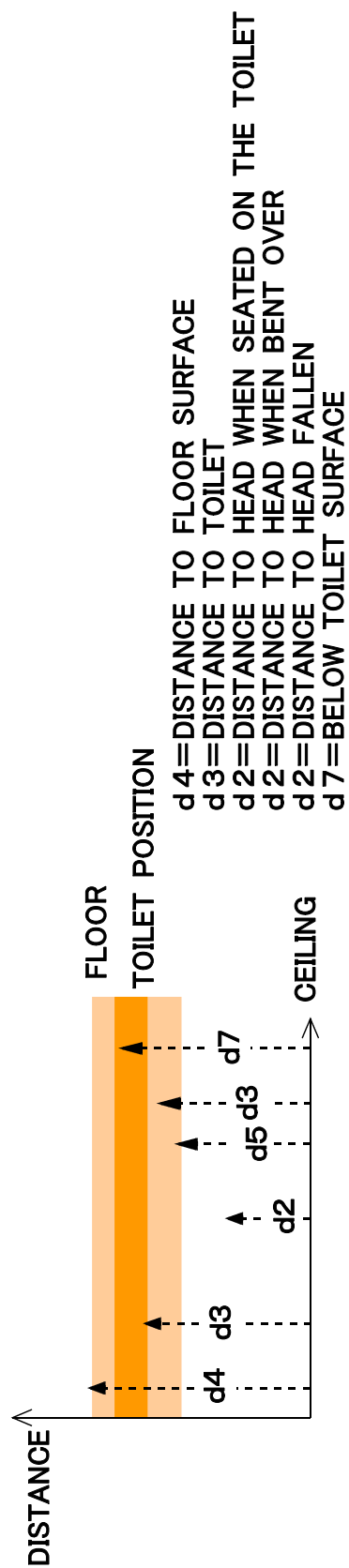
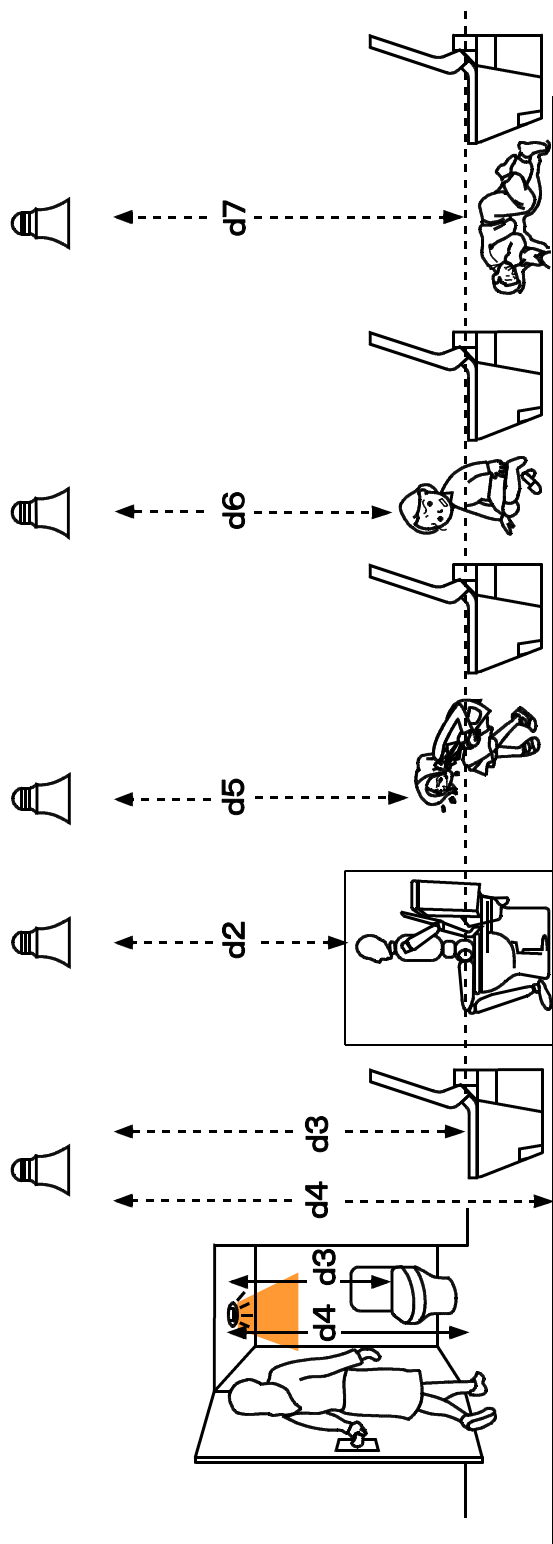
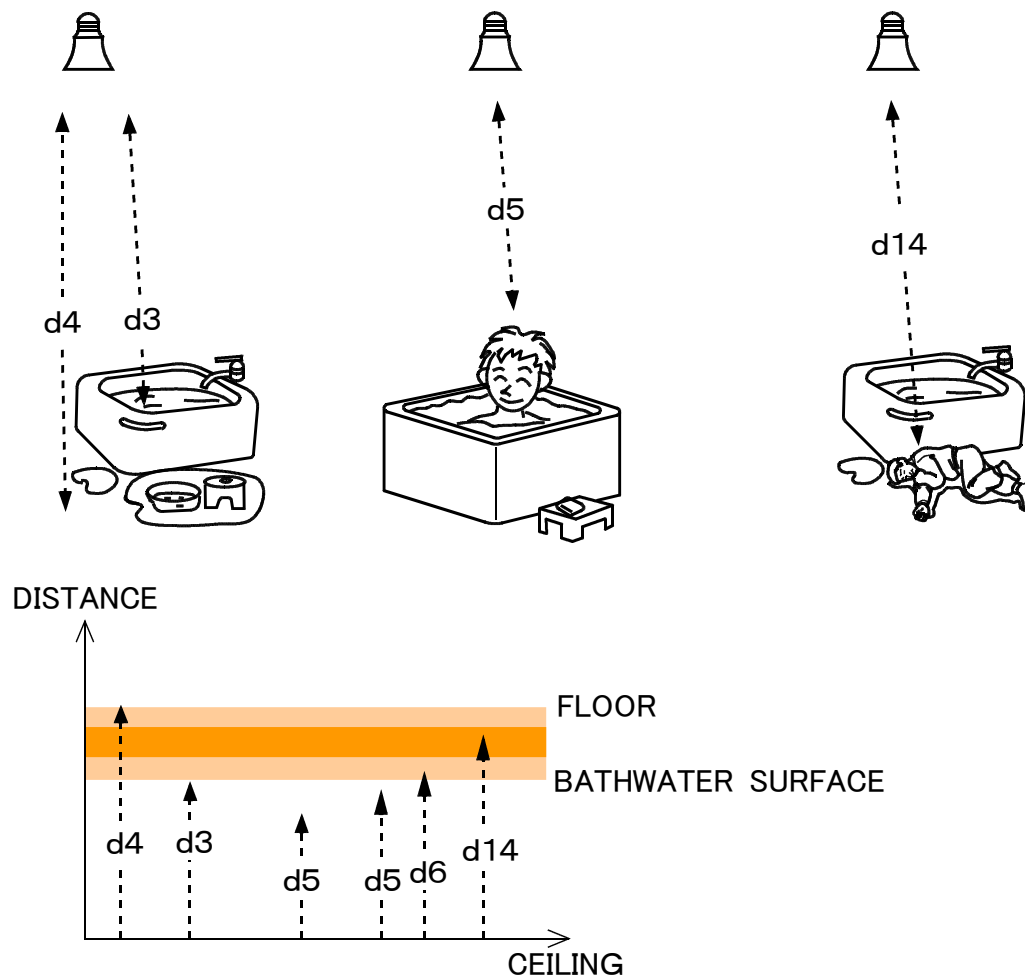


FIG. 18



d 4=DISTANCE TO FLOOR SURFACE
d 3=DISTANCE TO THE BATHWATER SURFACE
d 2=DISTANCE TO HEAD WHEN SOAKING IN THE BATH
d14=BELOW BATH SURFACE

FIG. 19

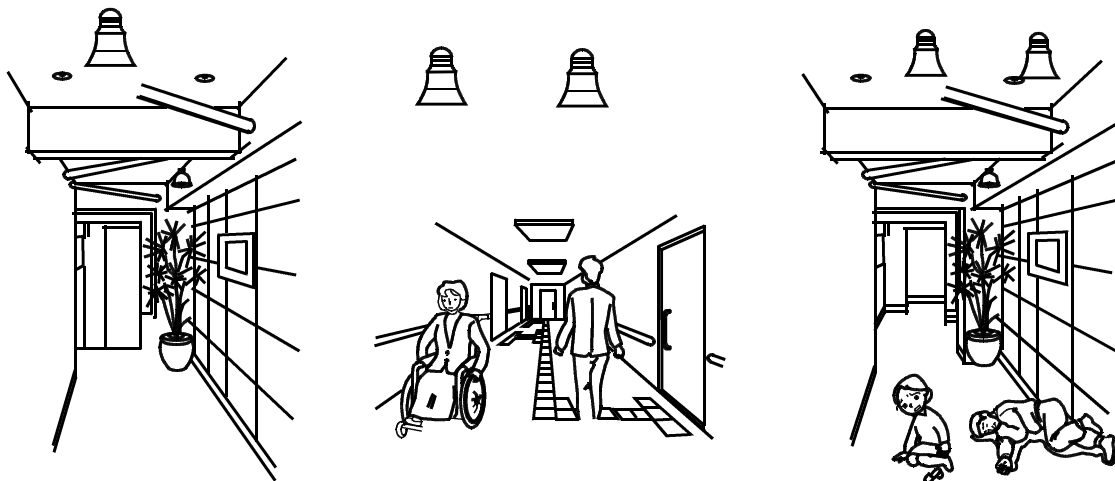
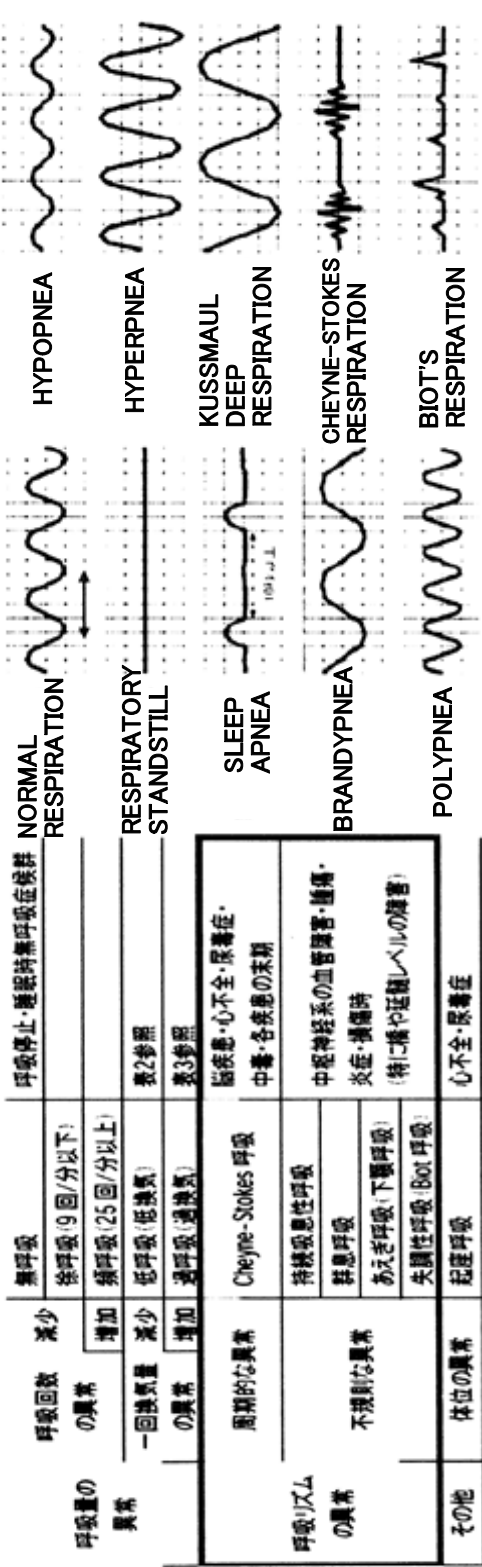
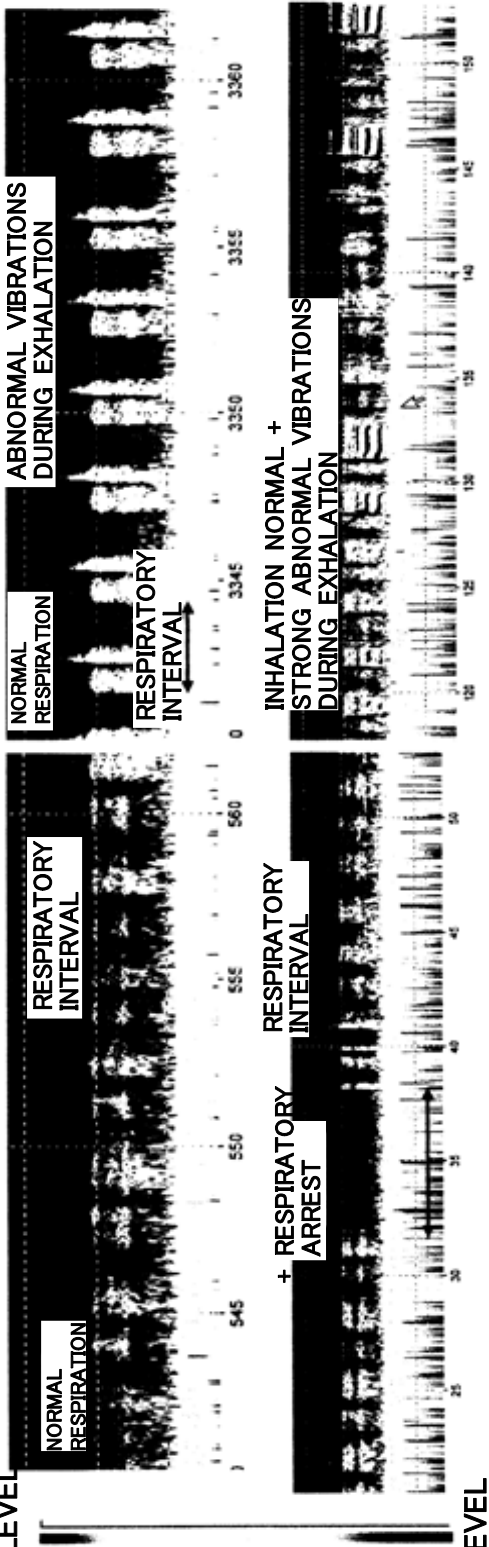


FIG. 20

【SEE NEXT PAGE】



HIGH LEVEL

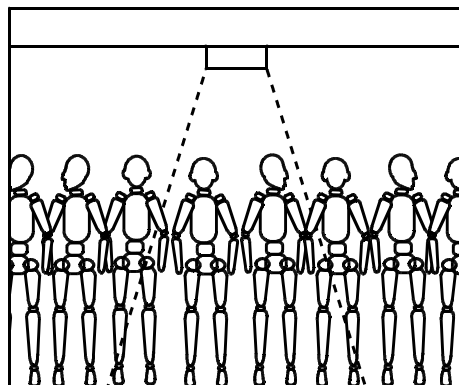


LOW LEVEL

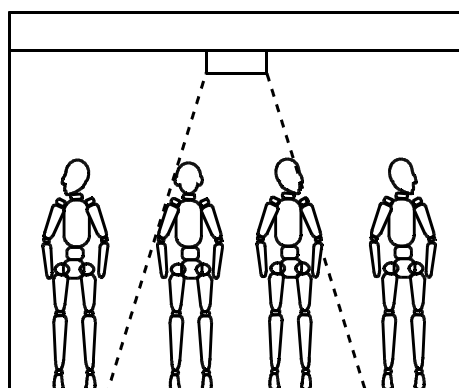
FIG. 20

ABNORMAL RESPIRATION AMOUNT	ABNORMAL NUMBER OF RESPIRATORIES	RESPIRATORY ARREST		RESPIRATION STANDSTILL /SLEEP APNEA SYNDROME
		REDUCED	BRADYPNEA (NINE RESPIRATIONS PER MINUTE OR LESS)	
			INCREASED	
RESPIRATORY RHYTHM	ABNORMAL TIDAL VOLUME	REDUCED	HYPOPNEA (HYPOVENTILATION)	SEE TABLE 2
		INCREASED	HYPERPNEA (HYPERVENTILATION)	SEE TABLE 3
	PERIODIC ABNORMALITY	CHEYNE-STOKES RESPIRATION		BRAIN DISEASE, CARDIAC FAILURE UREMIA, INTOXICATION, TERMINAL DISEASES
	IRREGULAR ABNORMALITY	CONTINUOUS INSPIRATORY BREATHING		VASCULAR DISORDER OF THE CENTRAL NERVOUS SYSTEM, TUMOR, INFLAMMATION, INJURED (DISORDER PARTICULARLY ON THE PONTO-MEDULLARY LEVEL)
		INTERMITTENT RESPIRATION		
		PANTING (RESPIRATION WITH LOWER JAW MOVEMENT)		
ATAXIC RESPIRATION (BIOT'S RESPIRATION)				
OTHER	ABNORMALITY OF PHYSICAL STATUS	ORTHOPNEA		CARDIAC FAILURE, UREMIA

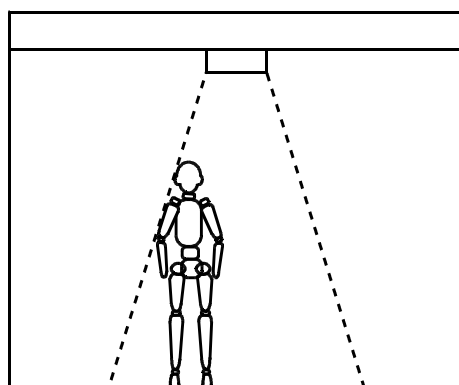
FIG. 21



(a)

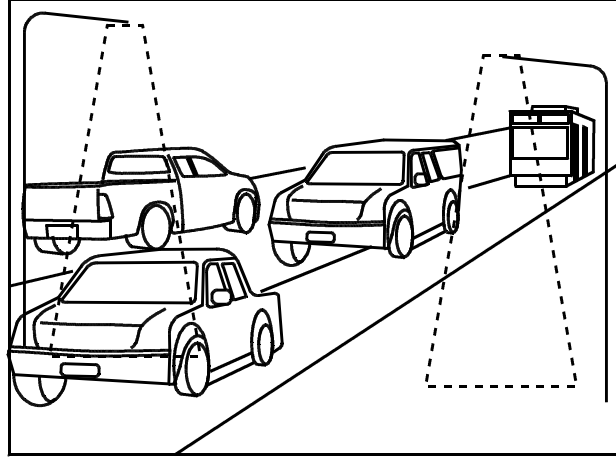


(b)

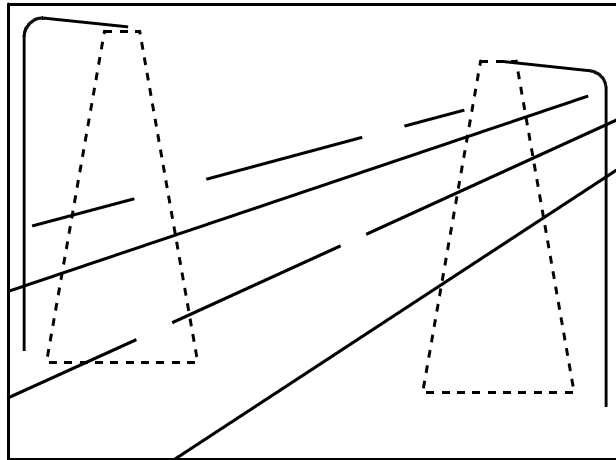


(c)

FIG. 22



(a)



(b)

FIG. 23

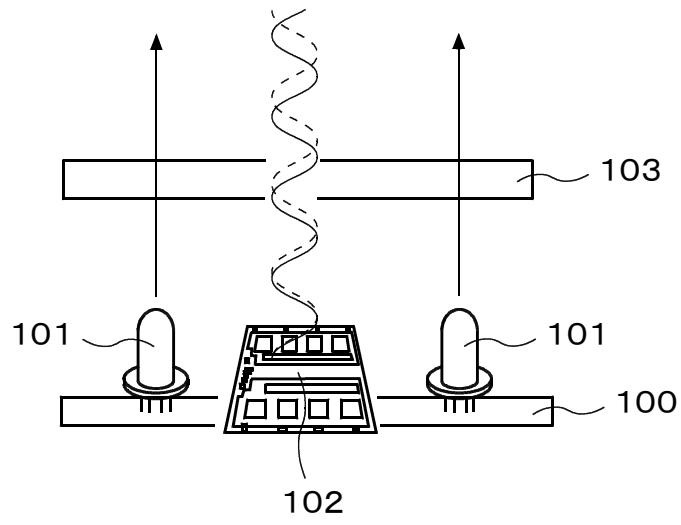


FIG. 24

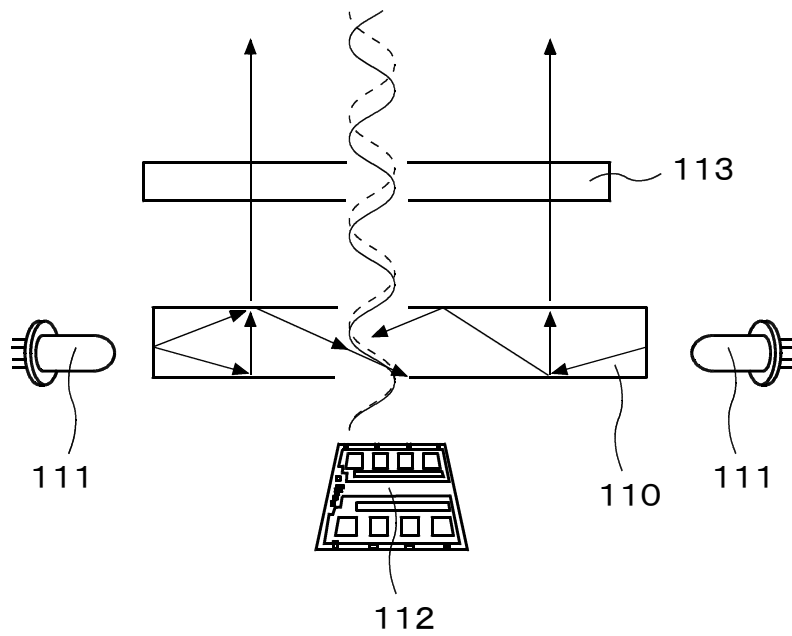


FIG. 25

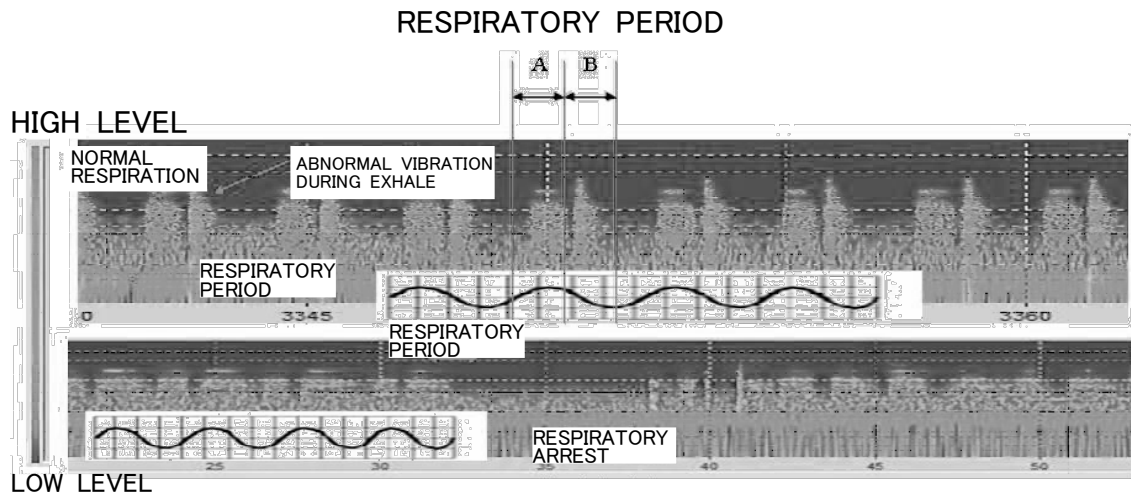
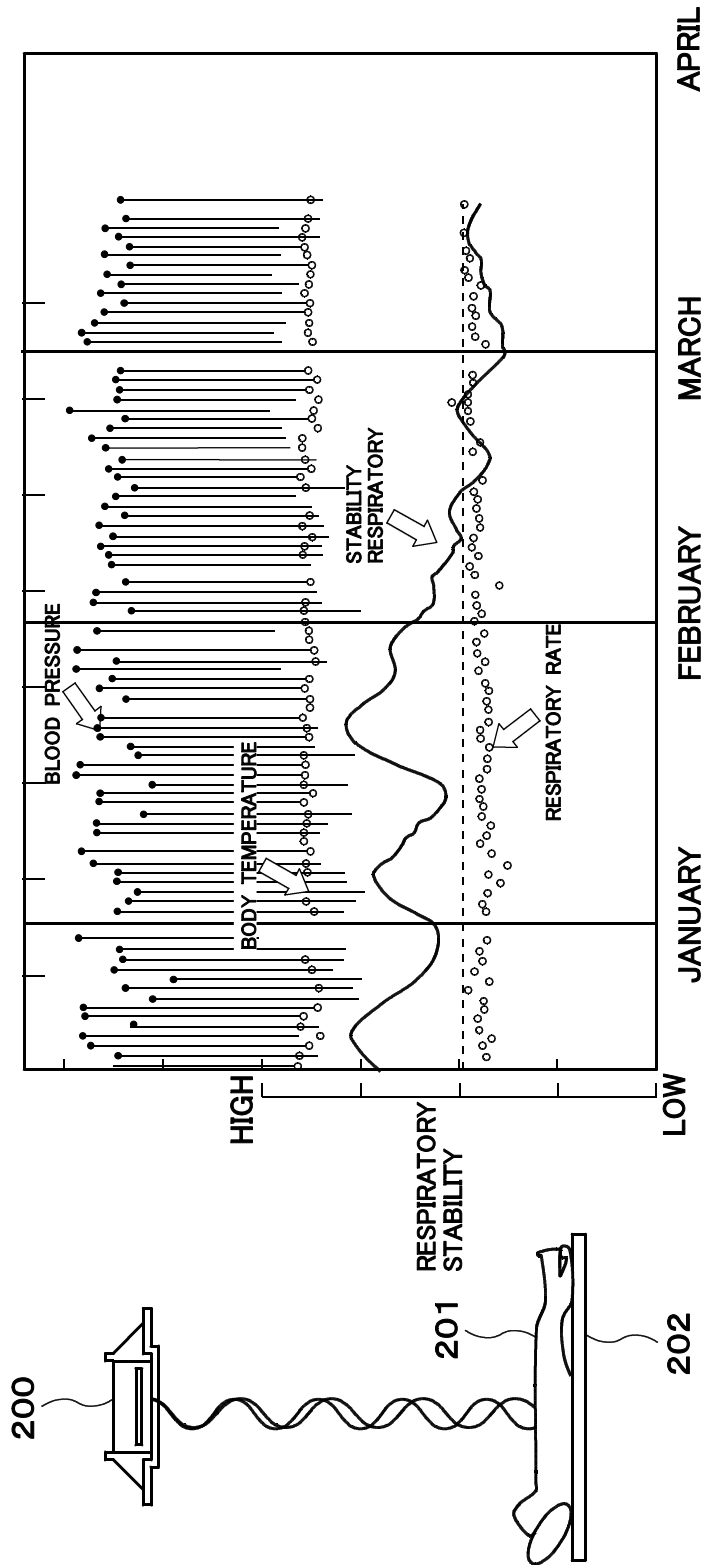


FIG. 26



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- (72) 発明者; および
(71) 出願人: 齋藤 光正(SAITOH Mitsumasa) [JP/JP];
〒2210064 神奈川県横浜市神奈川区鳥越 7-8
Kanagawa (JP).
- (74) 代理人: 藤巻 正憲(FUJIMAKI Masanori); 〒
2210052 神奈川県横浜市神奈川区栄町 5 番地 1
横浜クリエーションスクエア 19 階 朋友国際
特許事務所 Kanagawa (JP).

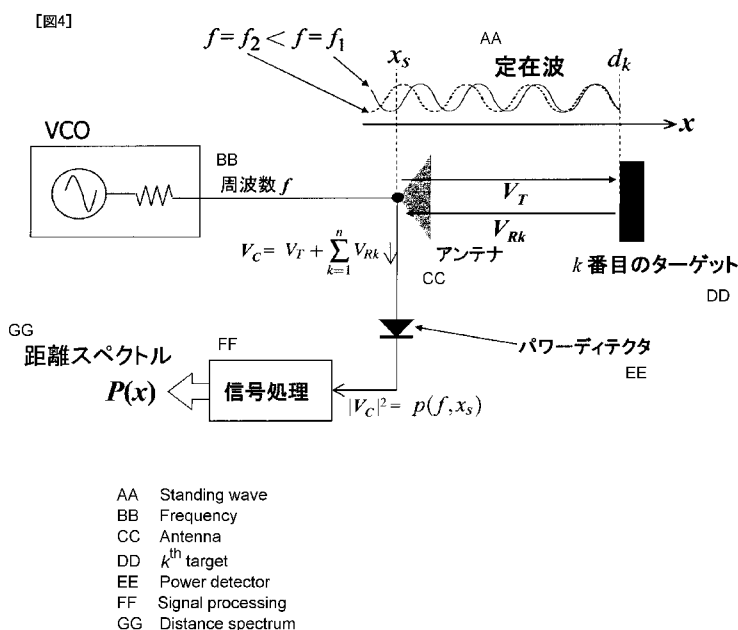
- (81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, RU, TJ, TM), ヨーロッパ (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:

— 国際調査報告 (条約第 21 条(3))

(54) Title: DEVICE FOR DETECTING HUMAN BODY ABNORMALITY BY STANDING-WAVE RADAR AND METHOD FOR USING SAME

(54) 発明の名称: 定在波レーダーによる人体異常検知装置及びその利用方法



(57) Abstract: In this invention, LEDs arranged in a circle, a standing-wave laser module, a substrate with a computation unit provided thereon, and an LED control unit are disposed inside a case. Illumination light is radiated outward from the LEDs. Microwaves are transmitted from the standing-wave laser module and the reflected waves subsequently detected. The computation unit combines the transmitted waves and the reflected waves to detect standing waves, and the distance to the body off which the waves reflected and minute displacements (e.g., heartbeat and breathing) are detected on the basis of such standing waves. Thus, simply installing the present invention in place of existing illumination found in toilets, bathing rooms, corridors and the like enables the detection of the position of a person therein, as well as his or her breathing rate, heart rate and the like, and also enables the prompt detection of sudden changes to the condition of the detected person.

(57) 要約:

[続葉有]



ケース内に、円周上に配置されたLEDと、定在波レーダーモジュールと、演算部が設けられた基板と、LED制御ユニットとが配置されている。LEDから照明光が外部に向けて出射されると共に、定在波レーダーモジュールからマイクロ波が送信され、反射波を検出する。演算部は、送信波及び反射波を合成して、定在波を検出し、この定在波から、被反射体までの距離及び微小変位（脈拍、呼吸）を検出する。これにより、トイレ、風呂場、廊下等に設置してある既存の照明器具の代わりに設置するだけで、人体の位置、呼吸数及び心拍数等を検出することができ、人体の容体の急変を迅速に検知することができる。

明 細 書

発明の名称：

定在波レーダーによる人体異常検知装置及びその利用方法

技術分野

[0001] 本発明は、ＬＥＤ（発光ダイオード素子）照明器具に関し、特に、定在波レーダーを使用して、照明器具の下方に位置する人体の危険状態を検知する機能を付加した定在波レーダーによる人体異常検知装置及びその利用方法に関する。

背景技術

[0002] 従来の人体を検知する照明器具は、人体を赤外線センサ、超音波センサ又はドップラーセンサにより検知して、照明のオン及びオフを制御するものであり（特許文献４，５）、人体の危険状態を検知できるものではなかった。

[0003] 特許文献１には、間取りが種々異なる監視対象の住居でも容易に設置することができ、居住者の行動推移及び生活空間毎の動向を容易に把握できる居住者監視システムとして、電波を放出し、その反射波を受信する電波センサと、この電波センサが受信する信号の振幅及び位相を検出して検出信号を得る検出部と、この検出信号から居住者又は動物の現在位置、動き、呼吸数及び心拍数を測定して居住者の又は動物の存在の有無を判定する信号処理部とを有するシステムが開示されている。

[0004] また、特許文献２には、ドップラー効果により監視対象の動きを検出する電波センサを備え、動き信号を、呼吸数の周波数帯域を通過周波数帯域とする呼吸数フィルタを通し、心拍数の周波数帯域を通過周波数帯域とする心拍数フィルタを通して、夫々の最大振幅から、呼吸数及び心拍数を算出する非接触式心肺機能監視装置が開示されている。

[0005] 更に、特許文献３には、住居内で、電波を送受信し、電波センサが受信した反射波に応じた信号から、居住者の呼吸に対応する周波数帯の呼吸信号と、この呼吸信号よりも高い周波数帯の動き信号とを抽出し、呼吸信号を検出

しつつ、動き信号に基づいて、居住者に一定時間以上動きがない場合に、居住者が異常状態にあると判定する監視システムが開示されている（請求項1）。また、この電波センサは、ドップラーセンサである（請求項3）。

先行技術文献

特許文献

[0006] 特許文献1：特開2010-66877号公報

特許文献2：特許第3057438号公報

特許文献3：特開2006-285795号公報

特許文献4：特開2011-34938号公報

特許文献5：特開2003-132704号公報

発明の概要

発明が解決しようとする課題

[0007] しかしながら、特許文献1に記載の従来技術においては、部屋毎に設置された（段落0007）複数の電波センサにより検出した位相又は振幅から、人の呼吸数及び心拍数を検出するが、居住者の位置情報については、位相又は振幅が変動しているセンサが監視している領域に居住者が位置し、位相又は振幅が変動していないセンサが監視している領域には居住者が不在として、居住者の位置を判定しているにすぎない（段落0013）。このように、特許文献1においては、居住者の位置については、どの部屋にいるかという程度の位置情報しか検出できない。また、居住者の異常については、居住者が通常長時間留まらない場所に長時間いるような場合を、異常と判断している（段落0026）。従って、特許文献1においては、人の異常を高精度にかつ迅速に検出することができない。

[0008] また、特許文献1のように、放射された電波の反射波の受信信号の振幅及び位相を検出する場合、その振幅及び位相を検出できる距離は数m以上離隔していることが必要であり、この数m以上離隔した位置からの反射波しか、振幅及び位相を検出することができない。検出器がドップラーレーダーであ

れば、近距離での心拍及び呼吸の検出が可能であるが、ドップラーレーダーは反射波の周波数の変化を検出するものであるので、特許文献1のように、信号の振幅及び位相の変化だけでは、心拍及び呼吸を検出することができない。

[0009] 更に、特許文献2及び3は、ドップラー効果により検出された信号から、最大振幅の周波数を呼吸数及び心拍数として、算出するものであるが、ドップラー方式であるため、対象物の速度は検出できるが、距離を検出することができない。よって、特許文献2及び3は、人体の位置を検出することができない。

[0010] 本発明はかかる問題点に鑑みてなされたものであって、トイレ、風呂場、廊下等に設置してある既存の照明器具の代わりに設置するだけで、人体の位置、呼吸数及び心拍数等を検出することができ、人体の容体の急変を迅速に検知することができる定在波レーダーによる人体異常検知装置及びその利用方法を提供することを目的とする。

課題を解決するための手段

[0011] 本発明に係る定在波レーダーによる人体異常検知装置は、
周波数掃引された電波を外部に送信し、 λ を送信波の波長として、外部の被反射体から受信した反射波を送信波長に基づく一定距離だけ離隔した2点にて検出し、送信波及び受信波から合成される定在波を検知する定在波検知部と、
前記定在波検知部が検知した合成波の周波数の強度分布から、その直流成分を除去し、フーリエ変換して、距離スペクトルを求めて、前記被反射体までの距離及び位相の変化分を演算する演算部と、
得られた被反射体までの距離成分から、測定空間が無人の場合に得られた距離成分を除去して、測定空間が無人の場合に得られた距離成分とは異なる距離情報を求めることにより、前記測定空間内に進入してきた測定対象者との間の距離成分を抽出する信号処理部と、
測定対象者との間の距離成分の強度分布の推移から、測定対象者の異常を検

知すると共に、前記位相の変化分から、前記測定対象者の身体状態並びに呼吸数及び脈拍を含む生理状態を判定する判定部と、
を有することを特徴とする。

- [0012] 本発明に係る他の定在波レーダーによる人体異常検知装置は、
周波数掃引された電波を外部に送信し、 λ を送信波の波長として、外部の被反射体から受信した反射波を送信波長に基づく一定距離だけ離隔した2点にて検出し、送信波及び受信波から合成される定在波を検知する定在波検知部と、
前記定在波検知部が検知した合成波の周波数の強度分布から、その直流成分を除去し、フーリエ変換して、距離スペクトルを求め、1周期内の前期間の距離スペクトルと、後期間の距離スペクトルとから、両距離スペクトルの位相差と、位相の変化分を演算する演算部と、
前記位相差から得られた被反射体までの距離成分から、測定空間が無人の場合に得られた距離成分を除去して、測定空間が無人の場合に得られた距離成分とは異なる距離情報を求めることにより、前記測定空間内に進入してきた測定対象者との間の距離成分を抽出する信号処理部と、
測定対象者との間の距離成分の強度分布の推移から、測定対象者の異常を検知すると共に、前記位相の変化分から、前記測定対象者の身体状態並びに呼吸数及び脈拍を含む生理状態を判定する判定部と、
を有することを特徴とする。

- [0013] 本発明の定在波レーダー内蔵型LED照明器具においては、例えば、
前記ケースの下部に、電球のソケット又はシーリングに装着可能なコネクタからなる給電部が設けられており、この給電部を介して、前記LED光源及び前記定在波検知部に給電されることを特徴とする。

- [0014] また、本発明の定在波レーダー内蔵型LED照明器具においては、例えば、
前記演算部、前記信号処理部及び前記判定部は、前記定在波検知部と共に、モジュールとして、前記ケース内に格納されていることを特徴とする。

[0015] 更に、本発明の定在波レーダー内蔵型ＬＥＤ照明器具においては、例えば、

前記判定部が、前記測定対象者との間の距離、又は前記測定対象者の呼吸数若しくは脈拍が、予め設定されている危険領域であると判定したとき、警報信号を外部の警報信号受信部に送信して、警報を発することを特徴とする。

[0016] そして、本発明の定在波レーダー内蔵型ＬＥＤ照明器具の利用方法は、上記定在波レーダー内蔵型ＬＥＤ照明器具を居宅又はビルの天井に設置して、居宅又はビル内の人体の異常を判定することを特徴とする。

[0017] 又は、本発明の定在波レーダー内蔵型ＬＥＤ照明器具の利用方法は、上記定在波レーダー内蔵型ＬＥＤ照明器具を乗り物の天井に設置して、乗り物内の人体の混み具合を判定することを特徴とする。

[0018] 又は、本発明の定在波レーダー内蔵型ＬＥＤ照明器具の利用方法は、上記定在波レーダー内蔵型ＬＥＤ照明器具を道路の照明のために設置して、道路にあふれた水の水位及び道路に位置する人体の混み具合を判定することを特徴とする。

発明の効果

[0019] 本発明によれば、定在波の分析により、微小距離から遠方まで、高精度で、測定対象者までの距離を測定できると共に、測定対象者の呼吸数及び脈拍等の微小変位も測定することができる。

図面の簡単な説明

[0020] [図1]本発明の実施形態に係るＬＥＤ照明器具の外観図である。

[図2]同じくその構造を示す縦断面図である。

[図3]同じくそのレーダー制御モジュール基板 7、定在波レーダーモジュール 8、及びＬＥＤ制御ユニット 10のブロック図である。

[図4]定在波レーダーの基本構成を示す図である。

[図5]送信波の波長を示す図である。

[図6]合成波のパワーを示す図である。

[図7]フーリエ変換後の図である。

[図8]合成波のパワーを示す図である。

[図9]複数個のターゲットに対する定在波レーダーの基本構成を示す図である。

[図10]目的の成分 $p_a(f_d, 0)$ を示すスペクトル図である。

[図11]ターゲットが2個の場合の距離スペクトルを示す図である。

[図12]合成波のスペクトルの真数部分と虚数部分を示す図である。

[図13]反射波の検出位置を説明する図である。

[図14]本発明の他の実施形態を示すブロック図及び波形図である。

[図15]距離の測定原理を示す図である。

[図16]同じく、距離の測定原理を示す図である。

[図17]本発明の実施形態のLED照明器具をトイレに設置した場合の利用方法を示す図である。

[図18]本発明の実施形態のLED照明器具を風呂場に設置した場合の利用方法を示す図である。

[図19]本発明の実施形態のLED照明器具を廊下に設置した場合の利用方法を示す図である。

[図20]代表的な異常呼吸パターンを示す図である。

[図21]本発明の実施形態のLED照明器具を電車内の監視に利用した状態を示す図である。

[図22]本発明の実施形態のLED照明器具を道路の状況の監視に利用した状態を示す図である。

[図23]直下型の照明器具を示す図である。

[図24]導光方式の照明器具を示す図である。

[図25]微小変位の検出により呼吸周期を測定したチャート図である。

[図26]呼吸のリズムを示す図である。

発明を実施するための形態

[0021] 以下、本発明の実施形態について、貼付の図面を参照して具体的に説明する。図1は本発明の実施形態に係る定在波レーダー内蔵型LED照明器具の

外観図である。ＬＥＤ照明器具のケースは、既存のソケットに装着可能な口金１と、ＡＢＳ等の樹脂素材又はアルミニウム材等で形成され、放熱機能をもつケース本体２と、透明若しくは半透明のＡＢＳ若しくはポリカーボネート等の透光性樹脂素材又はガラス等からなる透光性カバー３とから構成されている。透光性カバー３は、光を拡散させ、又は光ビームを絞り込むレンズ形状を有する。なお、照明器具として、口金１の代わりに、天井のシーリングに引っかけて装着する引掛けシーリング４を備えたものもある。このように、ＬＥＤ照明器具としては、多数のものが存在するが、本発明は、いずれのＬＥＤ照明器具にも適用することができる。

[0022] 図２は、本発明の実施形態に係るＬＥＤ照明器具の構造を示す図である。ＬＥＤ照明器具は、口金１と、ケース本体２と、カバー３とから構成されたケースの内部に、表面実装型ＬＥＤ６と、定在波レーダーモジュール８と、ＬＥＤ制御ユニット１０とが格納されている。口金１の下半部はソケットにねじ込まれる部分であり、導電性の材料で形成されており、この口金１の上半部は、絶縁性の支持体となっている。そして、口金１の絶縁性支持体の上端部には、その内周縁部に周方向に沿って延びるねじ部１ａが設けられており、ケース本体２の下端部にも、その外周縁部に周方向に沿って延びるねじ部２ａが設けられていて、ねじ部１ａをねじ部２ａに螺合させることにより、口金１とケース本体２とが連結されるようになっている。また、ケース本体２の上端部にねじ部２ｂが形成され、カバー３の下端部にねじ部３ａが形成されていて、ねじ部３ａをねじ部２ｂに螺合させることにより、カバー３とケース本体２とが連結されるようになっている。

[0023] ケース本体２内には、絶縁性の基板固定用ガイドフレーム１２が設置されており、このガイドフレーム１２に、ＬＥＤ制御ユニット１０の基板１１が固定されている。この基板１１はその面を上下方向にして、即ち、その面を照明器具の中心軸に平行にして、ガイドフレーム１２に固定されている。ＬＥＤ制御ユニット１０は、この基板１１上に搭載されており、ケース本体２及び口金１に囲まれた空間内に配置されている。この基板１１には、口金１

内で、外部から給電された100Vの交流電源が供給され、この電源は、基板11上に搭載された変換器でAC-DC変換された後、LED制御ユニット10に供給される。

[0024] ケース本体2の上端部には、放熱性が優れたアルミニウム基板5がその面を水平にして配置されている。このアルミニウム基板5はケース本体2の上端部の縁部に支持されているが、基板11はこのアルミニウム基板5を挿通して、カバー3内に進出している。そして、この基板11の上端部に、レーダー制御モジュール基板7がその面を水平にして支持されており、このレーダー制御モジュール基板7の上に定在波レーダーモジュール8が搭載されている。アルミニウム基板5には、複数個（図示例は7個）のLED6が、照明器具の中心軸の周りに等配の位置に、即ち、円周上の等間隔の位置に、配置されている。アルミニウム基板5の電源線には、基板11の配線が接続されていて、基板11上の配線を介して、LED制御ユニット10からアルミニウム基板5上に搭載されたLED6に給電され、LED6が発光するようになっている。また、レーダー制御モジュール基板7上に搭載された定在波レーダーモジュール8には、基板11上の配線を介して、給電され、定在波レーダーモジュール8はマイクロ波等の電波を送受信し、レーダー制御モジュール基板7は、検出信号を、無線で外部の中継機器に送信する。この定在波レーダーモジュール8の上面には、アンテナ8aが設置されており、電波はこのアンテナ8aを介して送受信される。なお、この定在波レーダーモジュール8はレーダー制御モジュール基板7に対して、傾斜可能になっており、この定在波レーダーモジュール8を傾斜させることにより、アンテナ8aの指向方向を調節できるようになっている。

[0025] 図3はレーダー制御モジュール基板7、定在波レーダーモジュール8、及びLED制御ユニット10のブロック図である。外部電源から、LED制御ユニット10の電源ブロック21に100Vの交流電源が入力され、電源ブロック21のAC-DCコンバータにより直流電源に変換されて、内部電源レギュレータ23に入力され、直流の5V電源が定在波レーダーモジュール

8及びLEDコントローラマイコン24に供給される。また、AC-DCコンバータの出力は、LEDドライバ22にも供給されてLED6の駆動に使用される。LEDコントローラマイコン24は定在波レーダーモジュール8からの制御信号を受けて、LEDドライバ22にLEDのオン／オフの制御信号及び調光の制御信号を出力し、LEDドライバ22はこの制御信号に基づき、LED6を駆動する。

[0026] レーダー制御モジュール基板7には、演算部31が設けられており、演算部31は、変調信号生成部38にてFM変調された周波数制御電圧を生成し、この周波数制御電圧をDA変換部39にてアナログ信号に変換された周波数制御信号がオペアンプ40を介して増幅された後、24GHz高周波モジュール35のVCOの制御入力に入力される。この周波数制御信号により、VCOは発信電波の周波数をスイープさせる。

[0027] 定在波レーダーモジュール8には、24GHz高周波送受信部35が設けられており、この24GHz高周波送受信部35は、24GHz帯VCO（電圧制御発振器）と平面アンテナ8aとが一体化されたモジュールである。そして、この送受信部35は、VCOにより平面アンテナ8aからマイクロ波が発信され、被反射体からの反射波がアンテナ8aに検出される。送受信部35には2個の検波器36a、36bが内蔵されており、検波器36a、36bは送信波及び受信波を検波する。

[0028] アンテナ8aから電波を送信すると、反射物体がある場合は、アンテナ8aに反射波が戻ってきて、周波数が同じで進行方向が異なる波が重なり、定在波が発生する。VCOとアンテナ8aとを接続する線路上及びアンテナ給電部には、送信信号（進行波）と受信信号（反射波）が混在し、それらの合成で定在波が発生する。この場合に、VCOに供給するスイープ電圧を、少なくとも発信電波が被反射体に反射して戻ってくるまでの時間は一定に保持する必要があるため、前記スイープ電圧は、ステップ状に変化させる必要がある。そして、VCOを制御して周波数を順次切り替えることにより、複数の周波数に対する混合波の信号レベルが検波器36a、36bにより検出さ

れる。検波器 36 a、36 b では、送信波の電力と、反射波の電力と、定在波によって生じた成分とが検出される。得られた検波信号は、オペアンプ 37 a、37 b で 400 kHz 以下の必要な帯域が増幅され、演算部 31 内の A/D 変換部 41 によりデジタル信号に変換された後、信号処理部 42 に入力される。信号処理部 42 においては、入力される信号は周期関数で、その周期は被反射体からの距離に逆比例しているため、これをフーリエ変換することにより、周期の逆数である周波数を求めることによって、この周波数から被反射体までの距離を求めることができる。また、得られた波形の位相を基に、被反射体の微小変位情報を検出することができる。例えば、24 GHz の場合は、微小変位は光速を $4\pi f$ で除算した値となり、約 ± 3.125 mm の範囲の変位を検出することができる。このように、検波器 36 a、36 b から検出された信号を信号処理することにより、被反射体からの距離、被反射体の速度及び変位を演算し、その経時変化を計測することにより、被反射体の動きを検出することができる。演算部 42 ではこの被反射体の動きを分析し、分析結果を警報部 43 に出力し、警報部 43 は LED の点灯、点滅、消灯、警報点滅等の制御信号を LED コントローラマイコン 24 に出力する。

[0029] また、演算部 31 は、得られた被反射体の状態を、高周波ユニット 32 を介して無線で、また出力端子 33 を介して有線で、外部に送信する。また、演算部 31 は、オーディオアンプ 34 を介して、警報音を発する。この無線送信、有線送信又は警報音は、いずれか 1 つの手段を採用すればよい。

[0030] 次に、本発明の実施形態の動作について、信号処理部 42 の構成と共に説明する。定在波は、図 4 に示すように、信号源である VCO から生成した送信波 V_T と、各ターゲットからの反射波 V_{R1} 、 V_{R2} 、 V_{R3} 、 \dots V_{Rn} との干渉によって生じる。定在波レーダーは、この定在波を利用することによって、ターゲットの有無を検知し、各ターゲットまでの距離 d_1 、 d_2 、 d_3 、 \dots d_n を測定する。

[0031] 送信波（進行波）は、信号源の振幅を A 、周波数を f 、光速を c (3×10^8 m/s)

0 m/s) とすると、各数式 1 で表される。但し、周波数 f は、図 5 に示すように、 f_0 と f_d で表される。

[0032] [数1]

$$V_T = A e^{j2\pi \int f(t - \frac{x}{c}) dt - \frac{x}{c}}$$

[0033] k 番目のターゲットの距離を d_k 、 x 軸上の任意の点における送信波に対する反射波の大きさの比を γ_k (反射係数の大きさ)、位相差を ϕ_k (反射係数の位相) とすれば、そのターゲットからの反射波は下記数式 2 にて表すことができる。

[0034] [数2]

$$V_{Rk} = A \gamma_k e^{j\phi_k} e^{j2\pi \int f(t - \frac{2d_k - x}{c}) dt - \frac{2d_k - x}{c}}$$

[0035] アンテナから検出される検波出力は、合成波になるので、振幅 V_c は下記数式 3 で表され、パワーは振幅の 2 乗であるので、合成波のパワーは、下記数式 4 で表される。

[0036] [数3]

$$V_C = V_T + \sum_{k=1}^n V_{Rk}$$

[0037] [数4]

$$p(f_d, x) = \left| V_T + \sum_{k=1}^n V_{Rk} \right|^2$$

[0038] 送信波の大きさは、反射波の大きさより桁違いに大きいので、 γ_k は 1 より極めて小さい。そこで、数式 4 に数式 1 及び数式 2 を代入して近似値をとると、下記数式 5 が得られる。

[0039]

[数5]

$$p(f_d, x_s) \approx$$

$$A^2 \left\{ 1 + \sum_{k=1}^n \gamma_k^2 + 2 \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi f_d}{c} (d_k - x_s) + \frac{4\pi f_0}{c} (d_k - x_s) - \phi_k \right) \right\}$$

[0040] この数式5において、 $\{ \}$ 内の第1項は、送信波のパワーを示し、第2項は、反射波のパワーを示し、第3項は、定在波によるパワーの変化分を示す。従来のレーダーは、第2項の反射波を受信して、信号処理を行うが、本発明においては、第3項の信号を信号処理する。このため、第1項目と第2項目を削除するため、合成波パワー $p(f_d, x_s)$ を f_d で微分して、この第1項目及び第2項目を除去する。

[0041] ここで、ターゲット（被反射体）の数が1であるとする、 $n=1$ を数式5に代入して、下記数式6が得られる。この数式6をグラフ化すると、図6のようになる。即ち、合成波のパワーは、固定値 $1 + \gamma^2$ と、周期関数との和となる。この図6において、周期関数の周波数（周期の逆数）は $c/2d$ となり、距離 d の成分が入る。このため、周期から周波数を求めれば、距離 d が求まることになる。数式6から、直流成分 $1 + \gamma^2$ を除去して、フーリエ変換すると、図7に示すように、距離スペクトル $P(x)$ が求まる。

[0042] [数6]

$$p(f, 0) = 1 + \gamma^2 + 2\gamma \cos\left(2\pi \frac{2d}{c} f - \Phi\right)$$

[0043] 先ず、下記数式7に示すフーリエ変換公式に対し、変数の置き換えをし、更に、観測位置を原点として、フーリエ変換すると、下記数式8に示す距離スペクトルが得られる。但し、 $\text{Sa}(z) = \sin(z)/z$ とする。なお、数式8では、直流分がカットされていない。周期のある関数をフーリエ展開すると、その関数に含まれる直流成分と、振動成分（ \sin 、 \cos ）に分解されてしまう。距離スペクトルは、その公式上、下記数式8のように表示される。

[0044] [数7]

$$\text{フーリエ変換公式} \quad F(\omega) = \int_{-\infty}^{\infty} f(t) e^{-j\omega t} dt$$

$$\text{変数の置き換え} \quad t \Rightarrow f_d \quad \frac{\omega}{2\pi} \Rightarrow \frac{2x}{c} \quad f(t) \Rightarrow p(f_d, x_s)$$

$$\text{観測位置を原点とする} \quad \Rightarrow x_s = 0$$

[0045] [数8]

$$P(x) = \int_{-f_W/2}^{+f_W/2} p(f_d, 0) e^{-j \frac{4\pi x f_d}{c}} df_d =$$

$$A^2 f_W \left\{ \left(1 + \sum_{k=1}^n \gamma_k^2 \right) \text{Sa} \left(\frac{2\pi f_W}{c} x \right) + \sum_{k=1}^n \gamma_k e^{-j\phi_k} e^{j \frac{4\pi f_0 d_k}{c}} \text{Sa} \left(\frac{2\pi f_W}{c} (x - d_k) \right) + \right.$$

$$\left. \sum_{k=1}^n \gamma_k e^{j\phi_k} e^{-j \frac{4\pi f_0 d_k}{c}} \text{Sa} \left(\frac{2\pi f_W}{c} (x + d_k) \right) \right\}$$

[0046] なお、数式8の $A^2 f_W (1 + \sum \gamma_k^2) \text{Sa} (2\pi f_W / c) x$ は、直流成分であるが、この直流成分は、実際の回路において、コンデンサにより除去される。

[0047] この数式8の第3式で表されるパワー $P(x)$ をグラフ図でみると、図8に示すようになる。そして、数式8の $\{ \}$ 内の第1項目の直流分を除去し、第3項目をcos成分を複素正弦波（解析信号）に変換して除去し、定在波成分である第2項目の成分を抽出することができる。しかし、図8に破線にて示すように、数式8の $\{ \}$ 内の第2項目の成分には、虚数側の信号が漏れ込んでしまう。つまり、この部分の定在波成分には、虚数側の信号が漏れ込んだ値になってしまう。

[0048] このような問題点を解消するために、本発明においては、図9に示すように、送信波とその反射波を合成した信号を検出する際に、送信波の波長を λ として、 $\lambda/8$ だけ離隔した2点にて、信号レベルを検出する。つまり、レーダーの進行方向を x 軸にとった場合に、被反射体である n 個（ n は自然数、図示は2個のみ）のターゲットからの反射波をアンテナが受信し、これを送信波と共に、 x 軸方向に $\lambda/8$ だけ離隔した2個のパワーディテクタで検

出し、これを信号処理する。このとき、この2個のディテクタが検出したパワーレベルを $p(f_d, x_1)$ 、 $p(f_d, x_2)$ とすると、 $x_1 = 0$ の位置に置かれたディテクタの出力は、検出パワーを示す数式5に、 $x_1 = x_s = 0$ を代入して、下記数式9に示す $p(f_d, 0)$ として求め、 $x_1 = -\lambda/8$ の位置に置かれたディテクタの出力は、検出パワーを示す数式5に、 $x_2 = x_s = -\lambda/8$ を代入して、下記数式9に示す $p(f_d, -\lambda/8)$ として求まる。この数式9に示すように、 $\lambda/8$ だけ離隔した2点で定在波を検出することにより、各位置 $(0, -\lambda/8)$ に置かれたディテクタの出力の定在波成分に、 \cos と \sin の直交成分が得られ、これにより、虚像信号を消去することができ、虚像側から漏れ込む信号の影響を解消することができる。即ち、 \cos と \sin の直交成分（X軸成分とY軸成分）から合成されるベクトルが求める解析信号である。通常、虚軸側の信号は測定できないのであるが、 $-\lambda/8$ の位置に、虚軸側の信号が計測できることになり、ベクトル合成信号を形成できる。このベクトルの回転速度が周波数になるので、本実施形態では、この周波数と位相を解析することになる。

[0049] [数9]

$x_1 = 0$ の位置に置かれたディテクタの出力

$$p(f_d, 0) = A^2 \left\{ 1 + \sum_{k=1}^n \gamma_k^2 + 2 \sum_{k=1}^n \underbrace{\gamma_k \cos \left(\frac{4\pi(f_0 + f_d)d_k}{c} - \phi_k \right)} \right\}$$

$x_2 = -\frac{\lambda}{8}$ （ただし、 $\lambda = \frac{c}{f_0}$ ） の位置に置かれたディテクタの出力

$$p(f_d, -\frac{\lambda}{8}) = A^2 \left\{ 1 + \sum_{k=1}^n \gamma_k^2 - 2 \sum_{k=1}^n \underbrace{\gamma_k \sin \left(\frac{4\pi(f_0 + f_d)d_k}{c} - \phi_k \right)} \right\}$$

[0050] この数式9における $x_s = 0$ の位置のディテクタの出力のうちの定在波成分を a 、 $x_s = -\lambda/8$ の位置のディテクタの出力のうちの定在波成分を b とす

ると、 a 、 b は下記数式10にて表される。そして、数式8の第3式を下記数式11に基づいて置き換えをすると、下記数式12及び数式13が得られる。即ち、数式10が求めるX軸、Y軸（実信号、虚軸信号）を実信号に変換された形に置き換えることが可能になる。数式13は、まさに、時間方向の信号と、回転軸での信号を表現しているが、結局、この数式13により、回転する解析信号を計算できることがわかる。

[0051] [数10]

$$a = \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

$$b = \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

[0052] [数11]

$$P_{DC} = A^2 \left(1 + \sum_{k=1}^n \gamma_k^2 \right)$$

$$m(f_d) = 2A^2 \sqrt{a^2 + b^2}$$

$$\theta(f_d) = \arctan \left(\frac{b}{a} \right)$$

$$a = \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

$$b = \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)$$

[0053] [数12]

$$p(f_d, x_s) = P_{DC} + m(f_d) \cos \left(\theta(f_d) - \frac{4\pi(f_0 + f_d)}{c} x_s \right)$$

[0054]

[数13]

$$\begin{aligned}
 m(f_d)e^{j\theta(f_d)} &= 2A^2(a + jb) \\
 &= 2A^2 \left\{ \sum_{k=1}^n \gamma_k \cos \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right) \right. \\
 &\quad \left. + j \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right) \right\} \\
 &= 2A^2 \sum_{k=1}^n \gamma_k e^{j \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right)}
 \end{aligned}$$

[0055] 数式 12 の右辺の P_{DC} は直流成分であり、 $m(f_d) \cos(\theta(f_d) - 4\pi(f_0 + f_d)/c \cdot x_s)$ は周期的に変化する定在波成分である。この定在波成分は、前述のごとく、 $x_s = 0$ の位置の成分 a と、 $x_s = -\lambda/8$ の位置の成分 b との合成成分 $a + jb$ は、 \sin と \cos との直交成分となり、 a と b とから解析信号を合成することにより、不要の信号（図 8 に示す虚数側から漏れ込んだ信号）による影響が除去される。よって、この値（数式 13 の信号）を解析することにより、図 10 に示す目的の成分 $p_a(f_d, 0)$ が得られる。図 12 は検波信号をフーリエ変換することにより求められる距離スペクトルを示すものであり、図 12 に示すように、送信周波数の掃引による定在波パワーの変動周期 f 、即ち、距離スペクトルの周波数 f は、 $c/(2d)$ で表される。よって、検波された合成波から直流成分を除去してフーリエ変換すれば、周波数 f を求めることができ、測定対象者までの距離 d を求めることができる。

[0056] 上述の説明では、 $x_s = 0$ の位置の成分 a と、 $x_s = -\lambda/8$ の位置の成分 b とから、解析信号を合成しているが、本発明はこれに限らず、 x 軸方向に離隔した 2 点間の距離を計測して、実軸及び虚軸で得られた信号に係数をかけて計算で合成信号を求めることもできる。図 13 に示すように、2 個のディテクタが検出したパワーレベルは、実軸成分（I 成分）と虚軸成分（Q

成分)として現れ、夫々、sin波形とcos波形の直交成分となる。このとき、反射波の検出位置が、x軸方向に $\lambda/8$ だけ離隔している場合は、位相 ϕ が 45° となり、実軸及び虚軸で得られた信号が1:1の関係にあり、従って、係数処理せずに、そのまま解析処理することができる。しかし、例えば、2点間の距離が $\lambda/6$ であった場合にも、位相が 60° となるだけで、実軸(x軸):虚軸(y軸)=1:2として、係数処理(虚軸が実軸の2倍)すれば、距離を解析することができる。よって、必ずしも、 $\lambda/8$ だけ離隔した2点間で反射波を検出する場合には限らないが、 $\lambda/8$ だけ離隔した2点間で反射波を検出することにより、演算処理が簡素になるという利点がある。

[0057] なお、ターゲットが2個の場合の距離スペクトルは、図11に示すように、 $x_s=0$ のパワー $p(f_d, 0)$ と $x_s=-\lambda/8$ のパワー $p(f_d, -\lambda/8)$ との合成波から直流分を除去して、フーリエ変換することにより、距離に対応する周波数が得られ、距離 d_1 , d_2 が求まる。

[0058] 図12は合成波の真数のスペクトルと、虚数のスペクトルを示す図である。電波の速度 c は、約30万km/秒である。発信波の周波数のスweepを、75MHz幅(f_w)で行った場合、この75MHzの波長は、 $c/f_w=4$ mである。しかし、波形を標本化するためのスweepは、往復で4mのため、行きはその半分の2mとなる。この2mを1周期と呼ぶ。そこで、スweep幅75MHzで20mを計測した場合、10周期を計測することになる。スweep時間が $256\mu s$ であるとする、観測する波形の周波数は、 $10/256\mu s=39kHz$ となる。同様に、200mを計測した場合、100周期であるので、 $100/256\mu s=390kHz$ となる。そして、図12に示す検出されたスペクトルの周波数のレベルは反射の強さを示し、周波数は距離に置き換えられる。よって、図11に示すように、フーリエ変換して39kHzのところにピークが現れると、それは、距離 $d_1=10$ mの位置からの反射波であることがわかり、390kHzのところにピークが現れると、それは、距離 $d_2=100$ mの位置からの反射波であることがわかる。このようにして、ディテクタの合成波の検出パワー $p_a(f_d)$ を微分

して直流成分を除去し、フーリエ変換すると、被反射体までの距離を求めることができる。

[0059] スweep幅が200MHzの場合、1周期が0.75mになるので、10mの計測は $10 / 0.75 = 13.3$ 周期を観測することになり、スweep時間が $256 \mu s$ である場合は、 $13.3 / 256 = 51.9 kHz$ となる。つまり、スweep幅が200MHzの場合は、51.9kHzにピークが現れた場合に、被反射体までの距離が10mと観測される。従って、スweep幅を調整し、スweep時間を調整することにより、検波出力の周波数を調整することができ、電波法の規制により帯域幅が制限されているので、一般的には、スweep時間を可変とすることにより、被反射体までの距離を測定する。

[0060] 次に、微小変位計測について説明する。数式8において、位相に着目すると、k番目のターゲットに対する位相は、下記数式14により求められ、距離 d_k の変化分を d_k 、位相の変化分を $\Delta \phi_k$ とすると、下記数式15が得られる。

[0061] [数14]

$$b = \sum_{k=1}^n \gamma_k \sin \left(\frac{4\pi(f_0 + f_d)}{c} d_k - \phi_k \right) \longrightarrow \psi_{Ak} = \frac{4\pi f_A}{c} d_k$$

[0062] [数15]

$$d_k = \frac{c}{4\pi f_0} \Delta \psi_k$$

[0063] この数式15から、距離dの微小変位が求まる。周波数が24GHzの場合は、 $\pm 3.125 mm$ の変位を検知することが可能となる。

[0064] 以上のように、信号処理部42において、被反射体からの反射波を送信波に合成した定在波の分析により、被反射体の距離及び微小変位を計測することができる。この計測結果を経時的に把握すれば、被反射体の距離、速度及

び変位を計測することができ、結局、被反射体の動きを計測できる。従来のレーダーであると、1～2 m以下は距離の測定が困難であったのに対し、本発明により、0 mに近い至近距離から、200 mの遠距離迄、距離の測定が可能である。また、本発明の場合は、微小変位の検知が可能であり、相対変位分解能は0.01 mmにも及ぶ。しかも、定在波レーダーの場合は、衣服を通して、衣服に包まれた人体にて直接反射するので、人体の異常を高精度で検知できる。

[0065] 次に、本発明の他の実施形態について、図14を参照して説明する。本実施形態は、生体情報を含む解析信号から、上記数式15に基づき呼吸数及び脈拍等の生体情報を検知すると共に、測定対象者の距離も検知するものである。図14は本実施形態の周波数スイープ信号（実軸及び虚軸の検波信号）を示す図である。発信波の中心周波数 f_0 が例えば24 GHzで、スイープ周波数が75 MHz（ f_w ）であるとする、この1周期（75 MHz）の期間内において、定在波を、前半の期間と後半の期間とに分けて解析処理する。即ち、発振器VCOを周波数 f_0 から $f_0 + f_{d1}$ に変化させた際（1周期の前半の期間）に得られた解析信号を b_1 とし、VCOを周波数 $f_0 + f_{d1}$ から $f_0 + f_d$ まで変化させた際（1周期の後半の期間）に得られた解析信号を b_2 として、フーリエ変換して解析すると、上記数式14と同様の式として、 b_1 と b_2 の解析信号のベクトル面における位相 ϕ_1 、 ϕ_2 は、下記数式16及び数式17で表される。よって、位相差 $\Delta\phi$ は、数式17から数式16を差し引いて、下記数式18で与えられる。これを、位相差を $2\pi/3$ として、図15に示す。この位相差 $\Delta\phi$ は、0から 2π までの範囲にある。なお、この位相差は、図16に示すように、解析信号の位相差 $\Delta\phi$ を意味し、位相の変化分（数式15の $\Delta\phi_k$ ）ではない。

[0066] [数16]

$$\phi_1 = \frac{4\pi(f_0 + f_{d1})}{c} dk - \theta_k$$

[0067] [数17]

$$\Phi_2 = \frac{4\pi(f_0 + f_d)}{c} dk - \theta k$$

[0068] [数18]

$$\Delta\Phi = \Phi_2 - \Phi_1 = \frac{4\pi(f_d - f_{d1})}{c} dk$$

[0069] この数式18を、 d_k について整理すると、下記数式19が得られる。

[0070] [数19]

$$dk = \frac{c}{4\pi(f_d - f_{d1})} \Delta\Phi$$

[0071] そして、 $f_d = 150\text{MHz}$ 、 $f_{d1} = 100\text{MHz}$ とすると、光速 $c = 3 \times 10^8$ (m/sec)であるから、位相差 $\Delta\Phi$ が $2\pi/3$ (120°)の場合は、数式18により、距離 d_k は $d_k = 3 \times 10^8 \times (2\pi/3) / 4\pi(150 \times 10^6 - 100 \times 10^6) = 1.0\text{m}$ と求まる。計測範囲は、0から 2π までであるので、1.0mの3倍の3mまでの距離の計測が可能である。このように、位相差から、微小変位による呼吸数及び脈拍等の生理状態と、距離 d との双方を求めることができる。

[0072] 次に、本発明の実施形態に係る定在波レーダー内蔵型LED照明器具の利用例について説明する。図17はトイレの天井に本実施形態のLED照明器具を設置して、人体の異常を監視する場合、図18は風呂の天井に本実施形態のLED照明器具を設置して、人体の異常を監視する場合、図19は廊下の天井に本実施形態のLED照明器具を設置して、人体の異常を監視する場合を示す。

[0073] 先ず、図17に示すように、トイレ内で居住者が倒れた場合について説明する。最初に、LED照明器具の設置後、無人の場合の定在波を分析することにより、LED照明器具から、床面までの距離 d_4 、便座までの距離 d_3

を測定しておく。そして、トイレに居住者が入室した後、本実施形態のLED照明器具により、距離 d_2 が計測される。この距離 d_2 は居住者の頭までの距離である。このとき、LED照明器具を点灯させてもよい。このように、 d_3 、 d_4 と異なる距離 d_2 が計測されたことにより、居住者がトイレを利用中であることが判定される。その後、トイレの利用によって適当な時間が経過した後、距離 d_2 が計測されなくなった場合は、通常のトイレの利用が行われたと判定される。距離 d_2 の観測が終了したときには、LED照明器具を消灯させてもよい。

[0074] 一方、利用者がトイレ内でうずくまっている場合及び座り込んでいる場合は、人体に異常が生じているのであるが、距離 d_5 及び距離 d_6 は、距離 d_3 、 d_4 とは異なると共に、便座に座っているときの頭までの距離 d_2 より大きいので、異常事態が発生したことがわかる。この場合に、利用者に意識があれば、LED照明器具は利用者の動きも検出するので、置物ではなく、人体であることも判定され、人体に異常が生じたことが確実に把握される。これにより、警報部43が警報信号を出力し、トイレ利用者の異常事態を外部に知らせる。また、同時に、LED照明器具を点滅させたり、調光により光量を増減させたり、又は色温度（色相）を変えることにより、危険状態を表示してもよい。トイレの扉の一部が曇りガラスである場合には、上述のLED照明器具による危険表示がトイレの外部の家人等に通知される。

[0075] また、利用者がトイレの床に倒れており、意識がない場合、LED照明器具は頭の距離 d_2 とは異なる距離 d_7 を計測するが、人体の動きは計測できない。しかし、本発明においては、位相分析により微小変位を検出することができるので、倒れている人の呼吸数及び脈拍等の人体の微小な変位も検出できる。そこで、本発明により、置物ではなく、人体が倒れていることを判定できる。この場合に、定在波レーダーにより、衣服を透過して、その下の人体の表面の動きを直接計測できるので、より確実に人体の異常を検知することができる。生体は反射係数が0.7以上の高い反射体であることから、人体の体表面を利用した変位計測が可能であり、衣服を透過して、人体の皮

膚の動きを直接計測できる。一般に、通常の大人の呼吸による変位振幅は、 $2 \sim 3 \text{ mm}$ 程度であり、定在波の微小変位は、 $\pm 3 \text{ mm}$ 程度の計測が可能のため、確実に人体の異常を検知することができる。また、演算部31に、呼吸数及び脈拍等の危険域又はリズムパターンを予め設定しておけば、呼吸等の検出により、人体か、置物かの区別だけでなく、人体の呼吸状況が重篤なものであるか、そうでないかも判定できる。

[0076] 図18に示す風呂場の場合、図19に示す廊下の場合等も、同様に、無人の場合の計測結果を求めておき、その計測距離を異常検知から排除しておけば、居住者の異常を判定することができる。このとき、通常の人体行動のときの検出される距離の範囲を設定し、その範囲から外れる距離を計測した場合に、居住者に異常が生じたと判定することもできる。しかも、微小変位から呼吸及び脈拍を計測できるので、人体であるか否か、及び人体の場合にどの程度重篤であるかも判定することができる。なお、図20は呼吸数を計測している状態を示すチャートである。図20に示すように、本発明により、異常呼吸を検出できることがわかる。

[0077] 図21は電車の天井に本発明の実施形態のLED照明器具を取り付け、LEDで照明すると共に、定在波を分析して電車の混み具合を判定する方法を示す。このように、本発明の実施形態のLED照明器具を電車の天井に取り付ければ、電車内の人体の数が多いか、少ないか及びその人体の数のおおよその数を検出することができる。従って、電車内が満員であるか、通常の混み具合であるか、又はすいているかを、電車の集中運行管理センタで容易に把握することができる。

[0078] 図22は、市街地の電柱に本発明の実施形態のLED照明器具を取り付け、LEDで照明すると共に、洪水で道路に水があふれた場合の水位及びこの異常な道路にどの程度の人が存在するかを判定する方法を示す。このように、本発明の実施形態のLED照明器具を電柱に取り付ければ、洪水で水があふれた道路の水位の変化及びその場合に道路にどの程度の人数が繰り出しているか等を、防災センターで管理判定することができる。

[0079] 本発明は、上記実施形態に限らず、種々の変形が可能である。例えば、図 23 は本発明の照明器具の他の形態を示す。この図 23 に示す照明器具は、図 2 に示す電球型と異なり、看板等の平面発光の表示面の裏側に LED を配置したものであり、直下型の照明器具である。基板 100 上の中心位置に、電波を外部に送信すると共に、外部からの反射波を受信する送受信部 102 が設置されており、この送受信部 102 の周辺に、複数の LED 101 が、例えば、等間隔で配置されている。これらの LED 101 及び送受信部 102 は、透光性のカバー 103 に覆われており、LED 101 からの照明光はこのカバー 103 を介して外部に出射し、送受信部 102 はこのカバー 103 を介して送信波及び反射波を送受信する。このカバー 103 は、光を拡散させる作用も有し、カバー 103 から LED 照明光が外部に向けて拡散し、滑らかな照明光として出射される。この照明器具においても、送受信部 102 から電波の送信及び反射波の受信が可能である。なお、この直下方式においては、照明カバーの背後に LED を配置して、LED 光が直接外部に出射するようにしている。よって、LED 光の光量は強いものの、送受信部 102 は、金属製の放熱基板 101 の背後（下方）に設けることはできず、レーダー送受信部の設置位置に制約がある。なお、平面発光の表示面とは、必ずしも、看板に限らないことは勿論である。看板のように、文字又は図形が付されていない壁のようなものでも良い。

[0080] 図 24 に示す照明器具は、導光方式の照明器具であり、導光板 110 の背後に電波の送受信部 112 を配置し、導光板 110 の側面から、複数の等間隔で並べられた LED 111 から発光した照明光を導光板 110 内に導入し、照明光を導光板 110 内で反射させて、導光板 110 からその表面に垂直の方向に出射させる。この導光板 110 の前方にも、透光性のカバー 113 が配置されており、このカバー 113 も光の拡散作用を有し、拡散により滑らかな照明光を出射させることができる。導光板 110 内に進入した LED 光は、導光板 110 内でその下面及び上面に反射し、導光板 110 の上面から、光量がその面内でほぼ均一な面発光光となって、外部に出射される。

この照明器具においても、送受信部 112 から電波の送信及び反射波の受信が可能である。この導光方式においては、照明光を面発光させることができると共に、レーダー送受信部 112 の位置は、導光板 110 の背後でも良く、その設置場所に制約がない。

[0081] 図 25 は、図 26 に示すように、ベッド 202 上に横臥した人 201 の呼吸の状態を、天井に設けた本実施形態の LED 内蔵型定在波レーダー 200 により、距離スペクトルの位相変化分から求めた微小変位として、測定したチャート図である。ベッド上に人が横臥した場合にも、無人の場合の距離スペクトルの計測結果を求めておき、ベッド又はその付属物の計測によるノイズを排除しておけば、ベッド上に人がいるか否かを判定することでき、本発明を離床センサとして使用することができる。この場合に、本発明は、微小変位から呼吸及び脈拍を計測できるので、計測対象物が人体であるか否かを確実に判定することができる。

[0082] 一方、空気を吸い込んだ時（吸気時）に肺は膨らみ、空気を吐いた時（呼気時）に肺は縮む。そこで、静止状態から空気を吸い込んだ時もピーク値（吸気時）（肺が膨らんだ状態）までの時間 A を計測し、静止状態から空気を吐いた時（呼気時）までの時間 B を計測すると、 $A + B$ が呼吸の周期となる。つまり、本実施形態の定在波レーダー 200 により、人 201 の胸の上下動を検知する。本実施形態においては、人 201 が衣服を身につけていても、また、人 201 の上に布団がかぶせられていても、定在波レーダー 200 により人 201 の呼吸による胸の上下動を検知することができる。図 26 の右図は、本実施形態の定在波レーダー 200 により計測したベッド 202 上の人 201 の呼吸数と、呼吸安定性との経時変化を示す図である。なお、図 26 には、別途計測された血圧及び体温の計測結果も示す。この図 26 において、呼吸安定性とは、図 25 に示す呼吸周期 $A + B$ における上下動の大きさに関係する。つまり、呼吸による胸の上下動が大きい場合には、図 25 に示す波が大きくなる。この胸の上下動の大きさが、小さくなったり、大きくなったりして、大小の変化の頻度が多いと、呼吸安定性が悪いといえる。図

26においては、胸の上下動の大きさの変化の頻度が小さい場合がグラフの縦軸で上方になり、呼吸安定性が高いといえ、胸の上下動の大きさの変化の頻度が大きい場合がグラフの縦軸で下方になる。この図26に示すように、この人201は、2ヶ月経過した頃から、呼吸安定性が悪くなり（下方に遷移し）、呼吸の乱れが大きくなったことがわかり、心不全の徴候が現れた。しかしながら、血圧及び体温の変化は認められないことは勿論のこと、呼吸数の変化も認められなかった。よって、血圧、体温、呼吸数を監視していただだけでは、心不全の徴候を検知することはできない。

[0083] また、周知のごとく、心臓の働きは、交感神経及び副交感神経によって拮抗的に制御されており、その心拍間隔は絶えず周期的に変動している。ここで、時系列的な心拍間隔の情報から生成した心拍間隔の変動情報（以下「心拍変動情報」という）を周波数解析すると、2個の主要な周波数成分が観察される。その一つは低周波数（L F）成分と呼ばれる0.05～0.15 Hzの周波数成分であり、主として交感神経及び副交感神経の活動状態を反映するものである。そして、もう一つは高周波数（H F）成分と呼ばれる0.15～0.45 Hzの周波数成分であり、主として副交感神経の活動状態を反映するものである。これらの各周波数成分は自律神経活動を反映しているため、そのスペクトルのパワーが自律神経の活動状況を示す指標として自律神経機能検査などにおいて利用されている。レム睡眠（R E M（Rapid Eye Movement））の状態は、身体の随意筋が弛緩状態でも脳が覚醒に近い状態を示し、目がまぶたの下で良く動いている状態である。ノンレム睡眠は熟睡の状態である。そして、入眠してから60～120分位で最初のレム睡眠が現れ、その後、レム睡眠が現れ、レム睡眠とノンレム睡眠とを繰り返す。その周期は一般的に90分（90～110分）で、就寝中に3～5回程度の周期がある。この場合に、眠りの浅いレム睡眠の時の方が、眠りの深いノンレム睡眠時より起床が楽になることが知られている。睡眠は生体の周期現象のひとつ（サーカディアンリズム：約24時間を周期とするリズム）であると考えられており、体内時計と呼ばれる神経組織によって制御されている。

[0084] 本発明の実施形態においては、心拍間隔の変動情報を周波数解析することにより、ノンレム睡眠とレム睡眠との時間間隔及び回数等を検出することができる、そこで、本実施形態の定常波レーダーによる人体異常検知装置を、心拍数による睡眠状態の異常を検知するために、利用することができる、また、本実施形態のLED内蔵型定常波レーダーによれば、心拍数から、ノンレム睡眠のタイミングとレム睡眠のタイミングを知ることができるので、就寝前の入眠誘導時には、LEDの色温度を赤系の低い色温度の照明にし、覚醒誘導が必要なときには、LEDの色温度の色温度を青系の高い色温度の照明にするようにすることができる。これにより、適切なタイミングで、照明光を変更することにより、覚醒状態及び入眠状態を適切に支援することができ、精神的な健康状態の維持に寄与することができる。

産業上の利用可能性

[0085] 本発明によれば、人の転倒等及び人体の呼吸数及び脈拍等の生理情報を検知することができ、人体が危険状態におちいったことを検知することができ、人体の安全の確保に多大の貢献をなす。

符号の説明

[0086] 1 : 口金
2 : ケース本体
3 : カバー
5 : アルミニウム基板
6 : LED
7 : 定常波レーダーモジュール基板
8 : 定常波レーダーモジュール
10 : LED制御ユニット
11 : 基板
12 : フレーム
31 : 演算部
35 : 24GHz高周波モジュール

4 2 : 信号処理部

請求の範囲

- [請求項1] 周波数掃引された電波を外部に送信し、 λ を送信波の波長として、外部の被反射体から受信した反射波を送信波長に基づく一定距離だけ離隔した2点にて検出し、送信波及び受信波から合成される定在波を検知する定在波検知部と、
- 前記定在波検知部が検知した合成波の周波数の強度分布から、その直流成分を除去し、フーリエ変換して、距離スペクトルを求めて、前記被反射体までの距離及び位相の変化分を演算する演算部と、
- 得られた被反射体までの距離成分から、測定空間が無人の場合に得られた距離成分を除去して、測定空間が無人の場合に得られた距離成分とは異なる距離情報を求めることにより、前記測定空間内に進入してきた測定対象者との間の距離成分を抽出する信号処理部と、
- 測定対象者との間の距離成分の強度分布の推移から、測定対象者の異常を検知すると共に、前記位相の変化分から、前記測定対象者の身体状態並びに呼吸数及び脈拍を含む生理状態を判定する判定部と、
- を有することを特徴とする定在波レーダーによる人体異常検知装置。
- [請求項2] 周波数掃引された電波を外部に送信し、 λ を送信波の波長として、外部の被反射体から受信した反射波を送信波長に基づく一定距離だけ離隔した2点にて検出し、送信波及び受信波から合成される定在波を検知する定在波検知部と、
- 前記定在波検知部が検知した合成波の周波数の強度分布から、その直流成分を除去し、フーリエ変換して、距離スペクトルを求め、1周期内の前期間の距離スペクトルと、後期間の距離スペクトルとから、両距離スペクトルの位相差と、位相の変化分を演算する演算部と、
- 前記位相差から得られた被反射体までの距離成分から、測定空間が無人の場合に得られた距離成分を除去して、測定空間が無人の場合に得られた距離成分とは異なる距離情報を求めることにより、前記測定空間内に進入してきた測定対象者との間の距離成分を抽出する信号処理

部と、

測定対象者との間の距離成分の強度分布の推移から、測定対象者の異常を検知すると共に、前記位相の変化分から、前記測定対象者の身体状態並びに呼吸数及び脈拍を含む生理状態を判定する判定部と、
を有することを特徴とする定在波レーダーによる人体異常検知装置。

[請求項3]

少なくとも一部に透光性のカバーを備えたケースと、
このケース内に格納され、前記カバーを介して照明光を外部に照射する発光体としてのLED光源と、
を有し、
前記定在波検知部、前記演算部、前記信号処理部、及び前記判定部が、
前記ケース内に格納され、前記定在波検知部は、前記カバーを介して電波を送受信するものであり、
LED照明器具内に内蔵されていることを特徴とする請求項1又は2に記載の定在波レーダーによる人体異常検知装置。

[請求項4]

前記ケースの下部に、電球のソケット又はシーリングに装着可能なコネクタからなる給電部が設けられており、この給電部を介して、前記LED光源及び前記定在波検知部に給電されることを特徴とする請求項3に記載の定在波レーダーによる人体異常検知装置。

[請求項5]

前記演算部、前記信号処理部及び前記判定部は、前記定在波検知部と共に、モジュールとして、前記ケース内に格納されていることを特徴とする請求項3又は4に記載の定在波レーダーによる人体異常検知装置。

[請求項6]

前記判定部が、前記測定対象者との間の距離、又は前記測定対象者の呼吸数若しくは脈拍が、予め設定されている危険領域であると判定したとき、警報信号を外部の警報信号受信部に送信して、警報を発することを特徴とする請求項1乃至5のいずれか1項に記載の定在波レーダーによる人体異常検知装置。

[請求項7]

前記判定部が、前記測定対象者との間の距離、又は前記測定対象者の

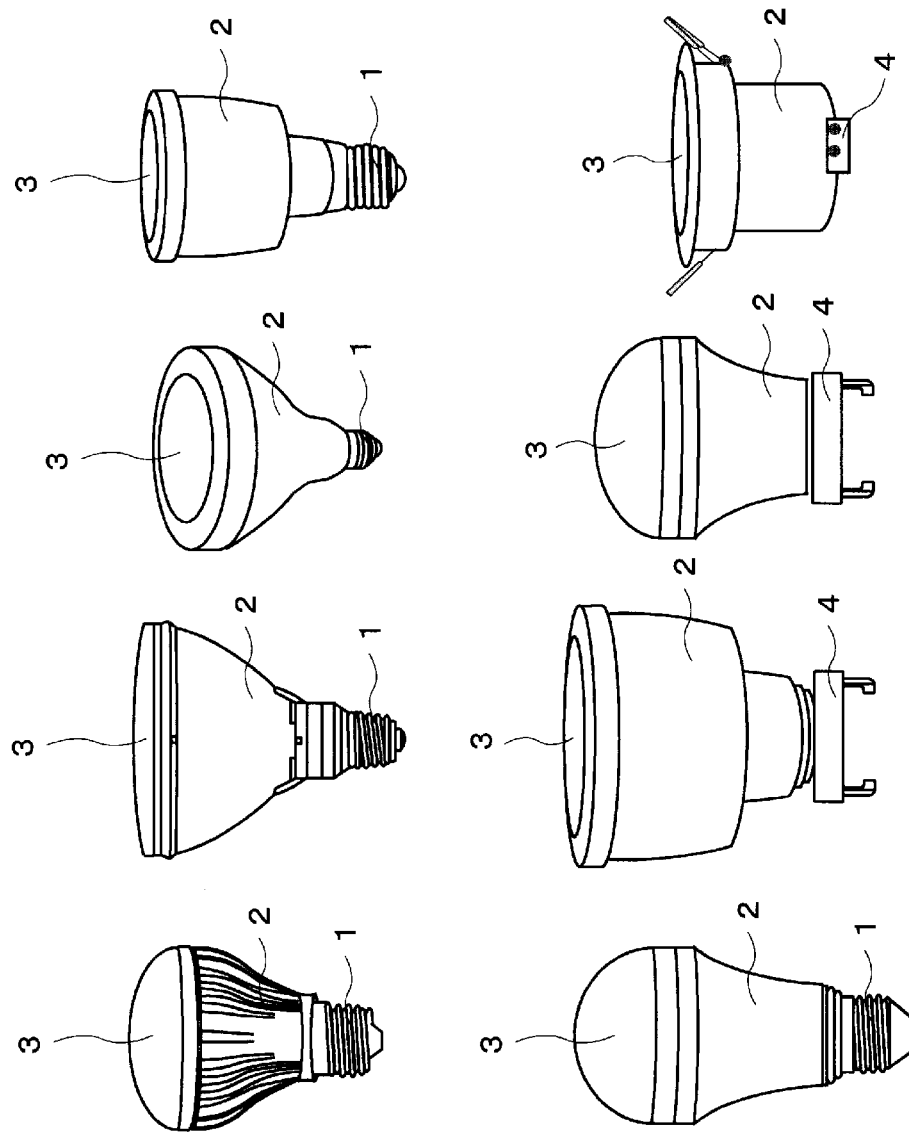
呼吸数若しくは脈拍が、予め設定されている危険領域であると判定したとき、前記ＬＥＤ照明器具を、点滅させ、又は調光を変化させることにより、警報を発することを特徴とする請求項３乃至５のいずれか１項に記載の定在波レーダーによる人体異常検知装置。

[請求項８] 前記請求項１乃至７のいずれか１項に記載の定在波レーダーによる人体異常検知装置を居宅又はビルの天井に設置して、居宅又はビル内の人体の異常を判定することを特徴とする定在波レーダーによる人体異常検知装置の利用方法。

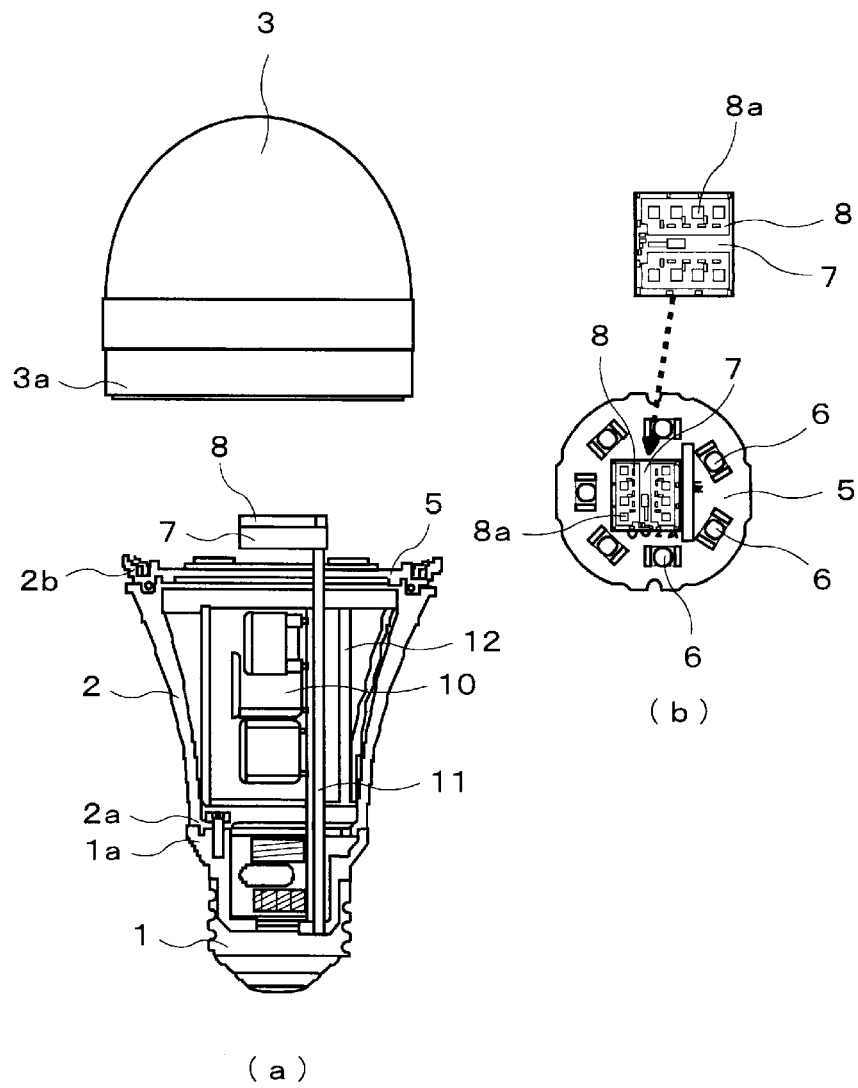
[請求項９] 前記請求項１乃至７のいずれか１項に記載の定在波レーダーによる人体異常検知装置を乗り物の天井又は通路若しくはトンネルの天井に設置して、その場所の人体の混み具合を判定することを特徴とする定在波レーダーによる人体異常検知装置の利用方法。

[請求項１０] 前記請求項３乃至５のいずれか１項に記載のＬＥＤ照明器具内蔵型定在波レーダーによる人体異常検知装置を前記ＬＥＤ光源による道路の照明のために設置して、道路にあふれた水の水位及び道路に位置する人体の混み具合を判定することを特徴とする定在波レーダーによる人体異常検知装置の利用方法。

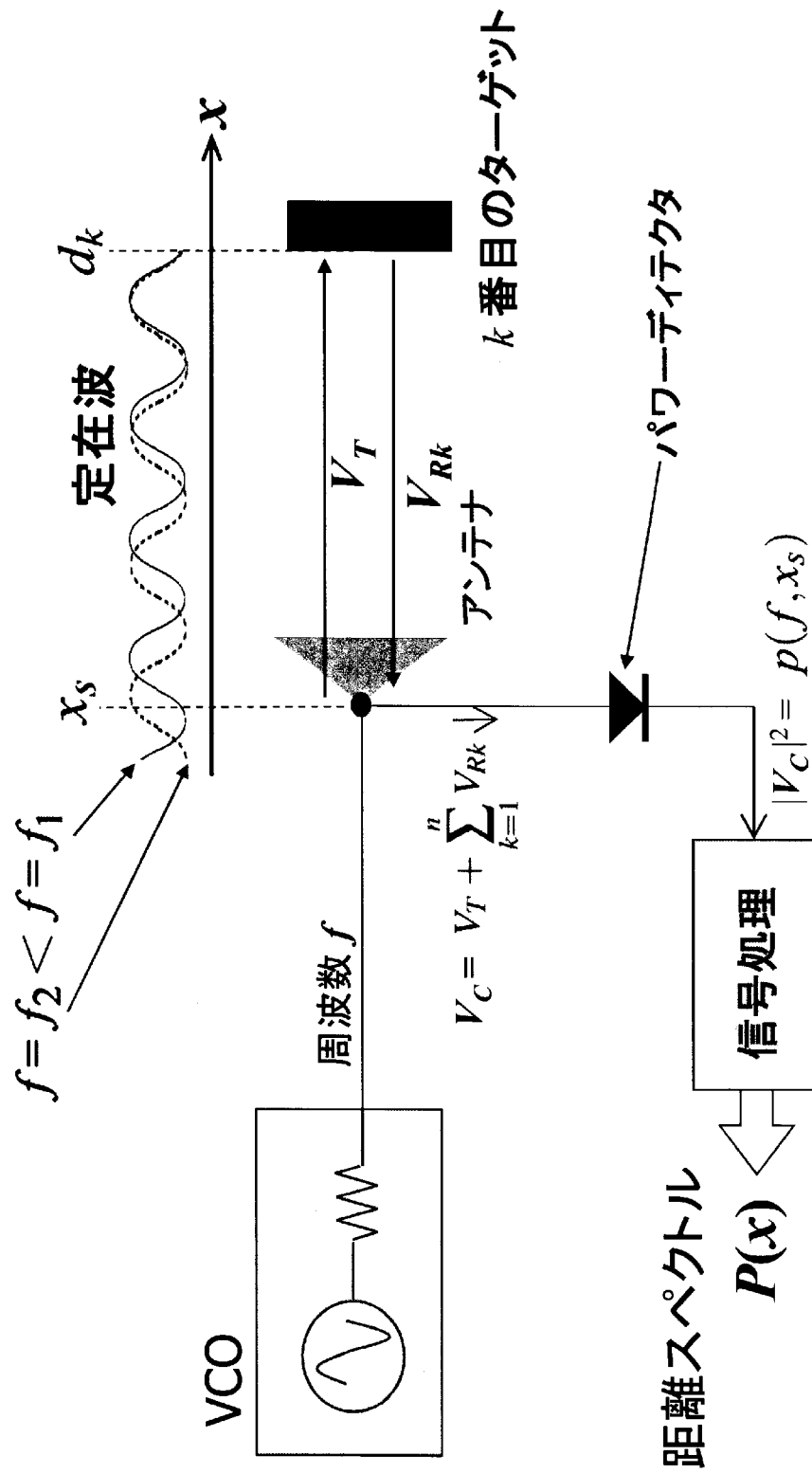
[図1]



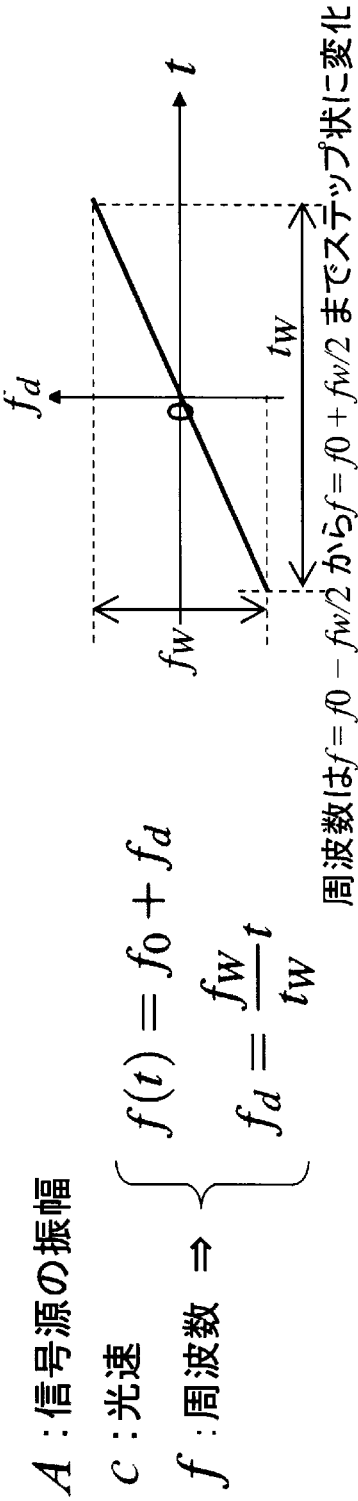
[図2]



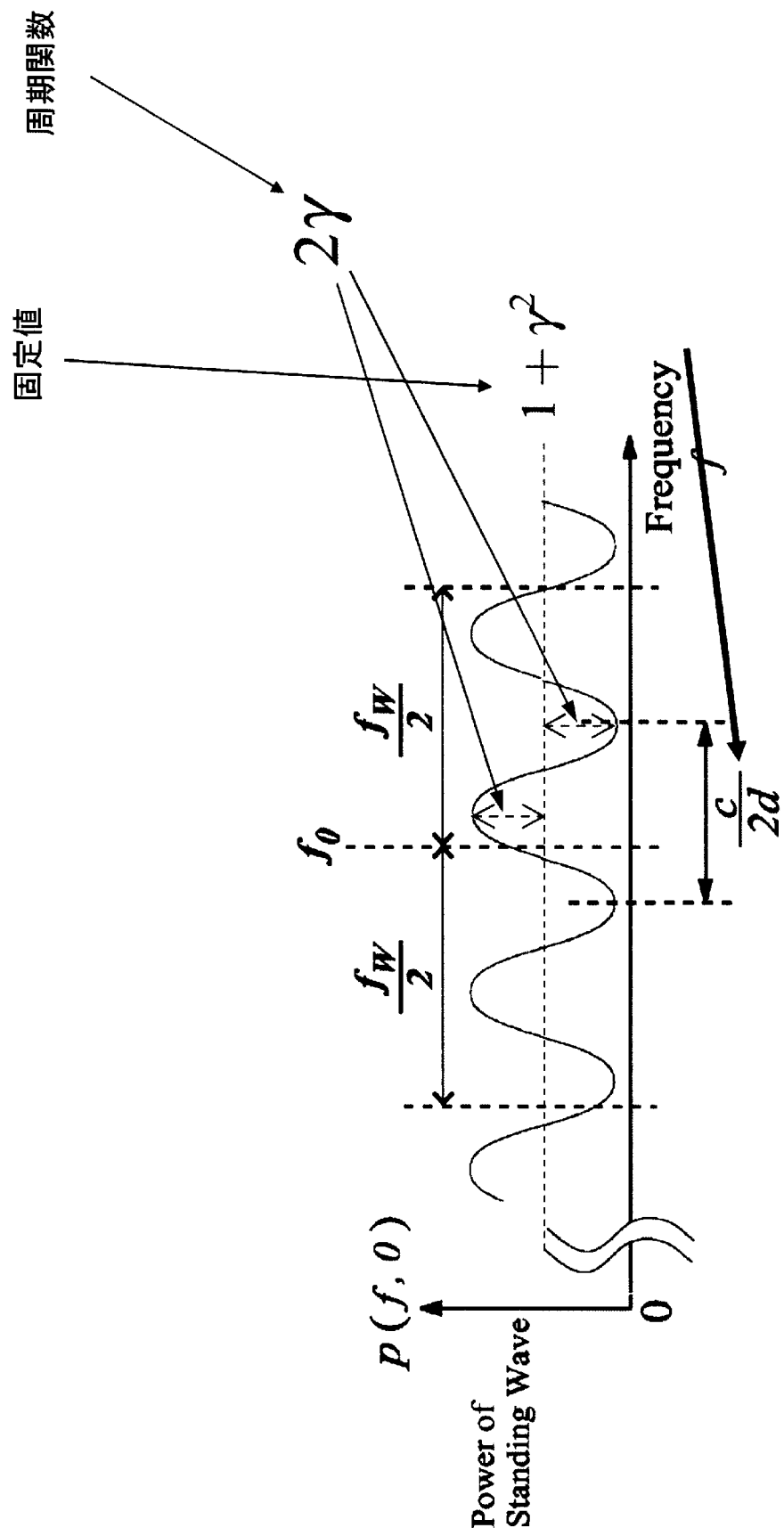
[図4]



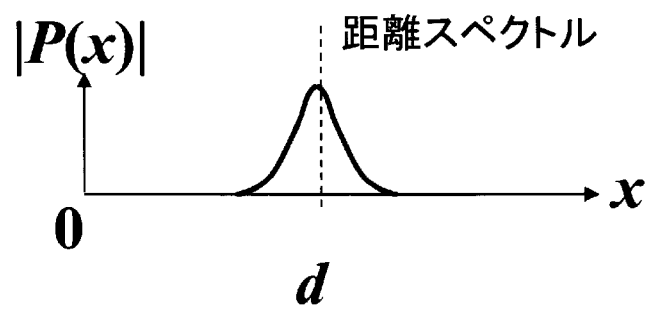
[図5]



[図6]



[図7]

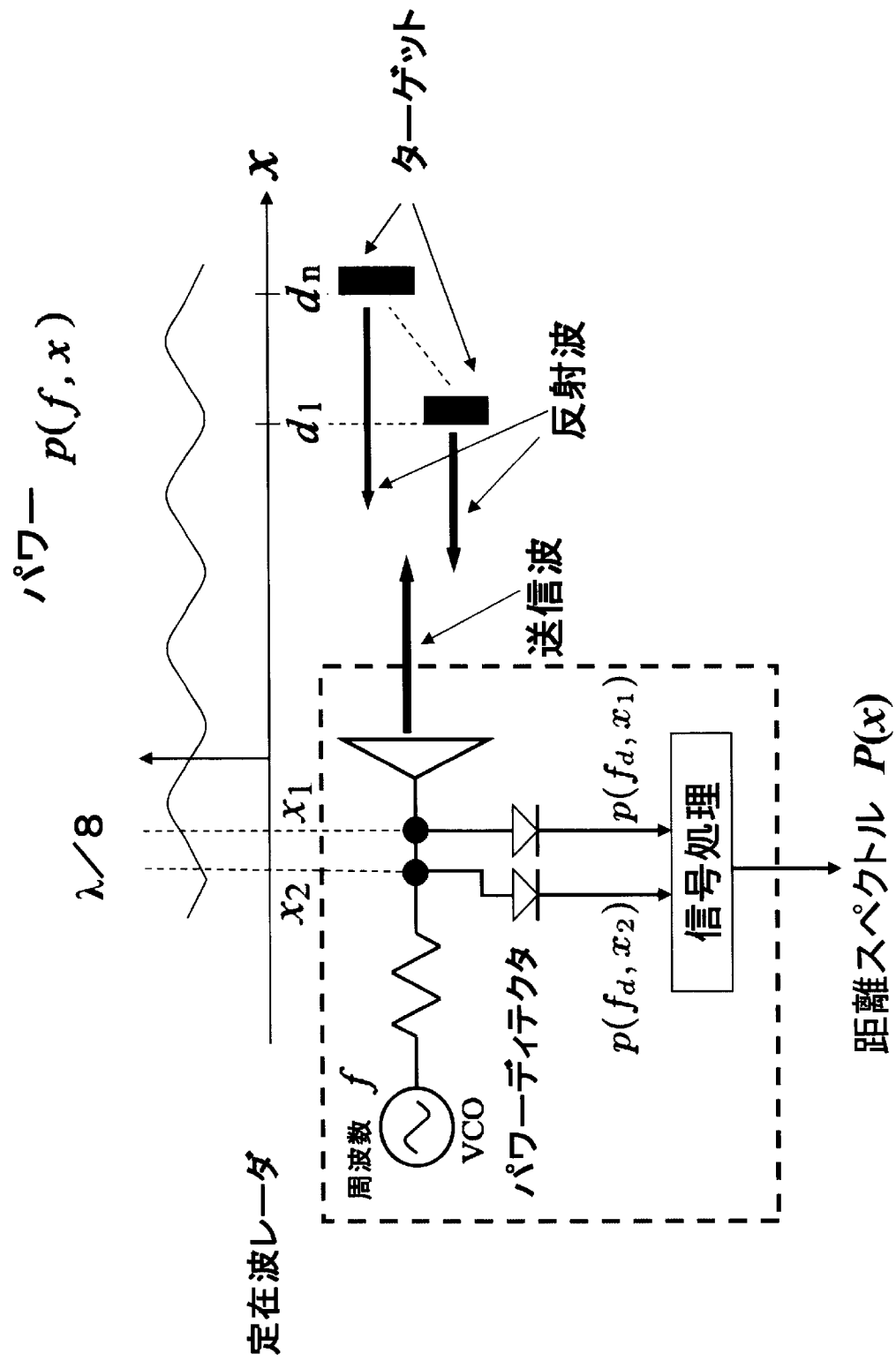


[図8]

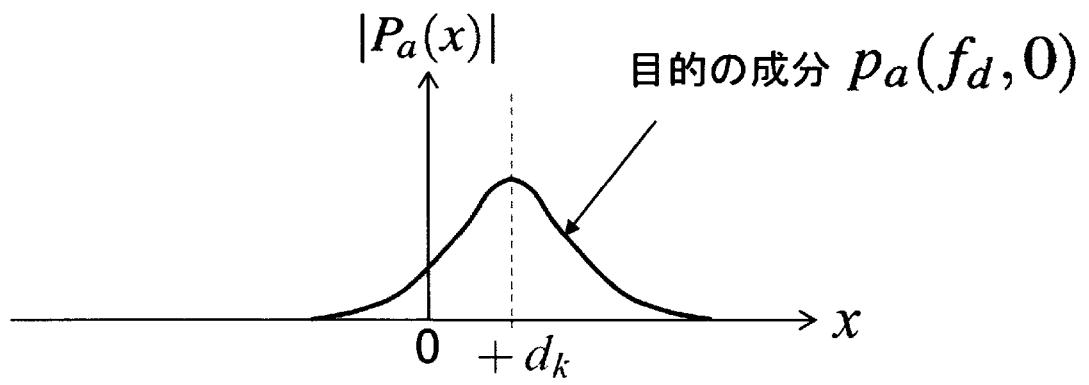
$$\begin{aligned}
 P(x) = & A^2 f_W \left\{ \left(1 + \sum_{k=1}^n \gamma_k^2 \right) Sa \left(\frac{2\pi f_W}{c} x \right) + \sum_{k=1}^n \gamma_k e^{-j\phi_k} e^{j\frac{4\pi f_0 d_k}{c}} Sa \left(\frac{2\pi f_W}{c} (x - d_k) \right) + \right. \\
 & \left. \sum_{k=1}^n \gamma_k e^{j\phi_k} e^{-j\frac{4\pi f_0 d_k}{c}} Sa \left(\frac{2\pi f_W}{c} (x + d_k) \right) \right\} \cdot
 \end{aligned}$$

虚数側の信号

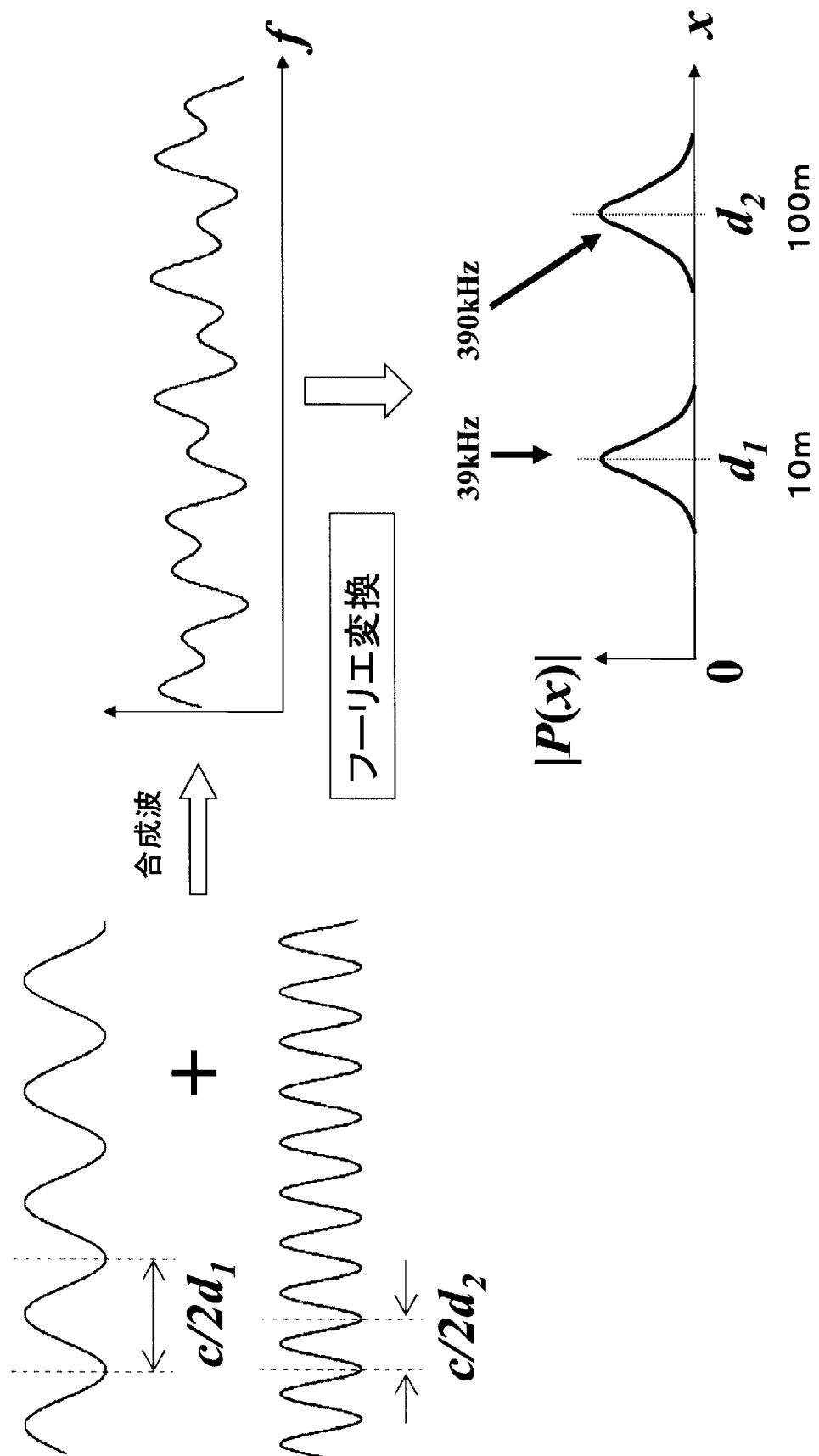
[図9]



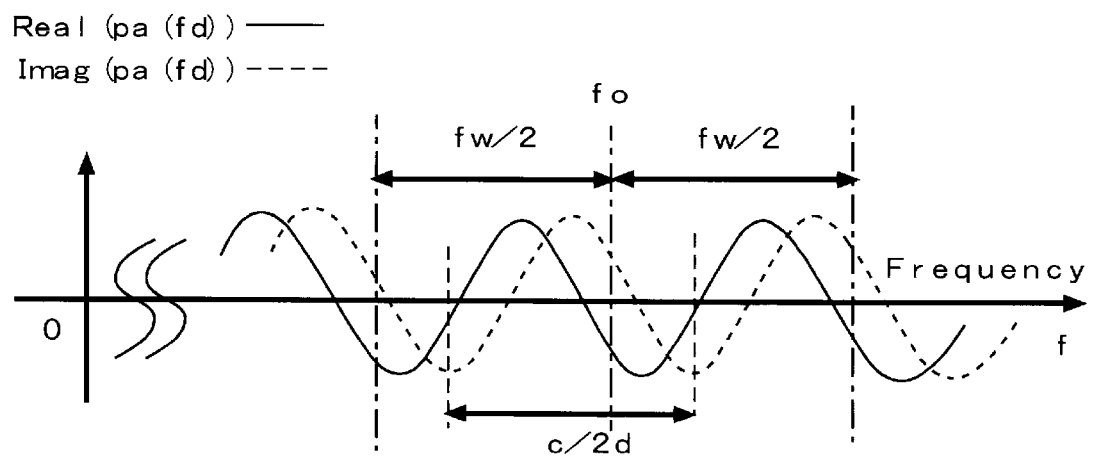
[図10]



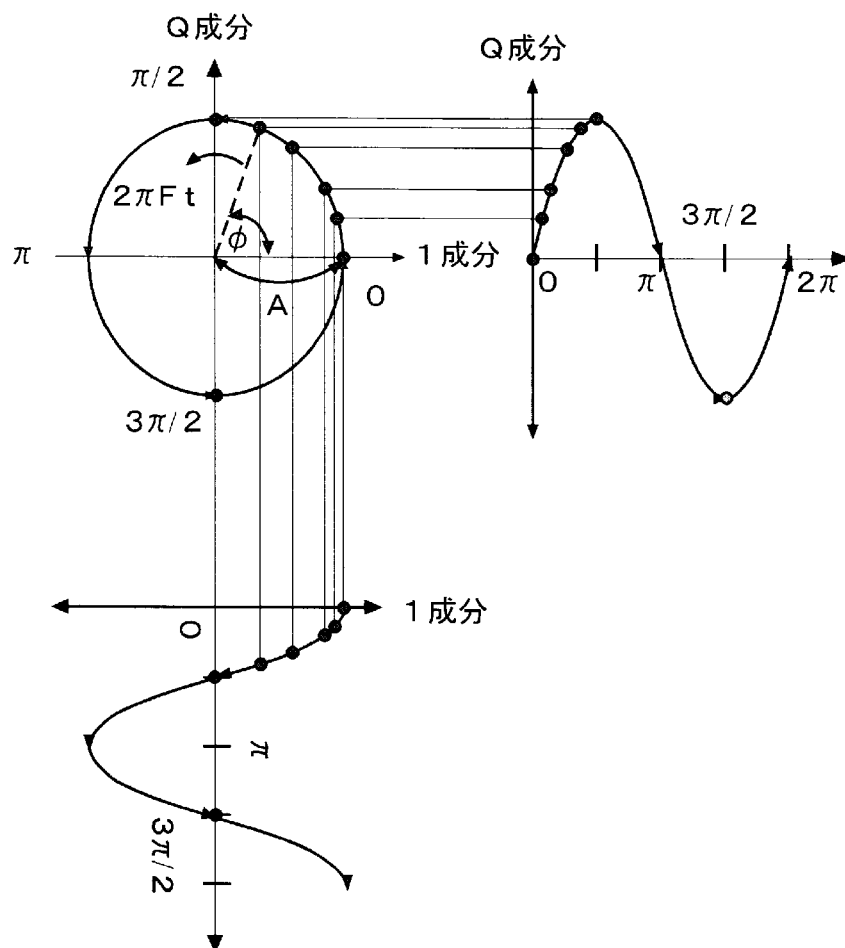
[図11]



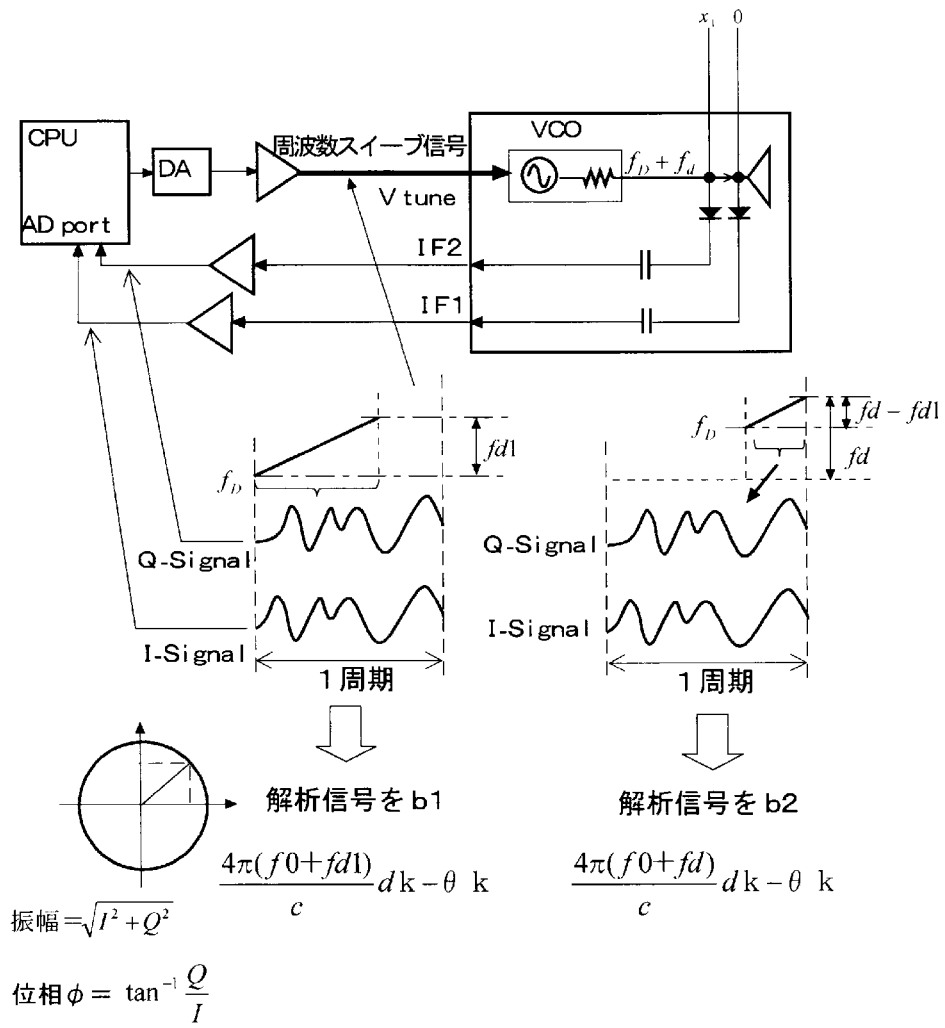
[図12]



[図13]



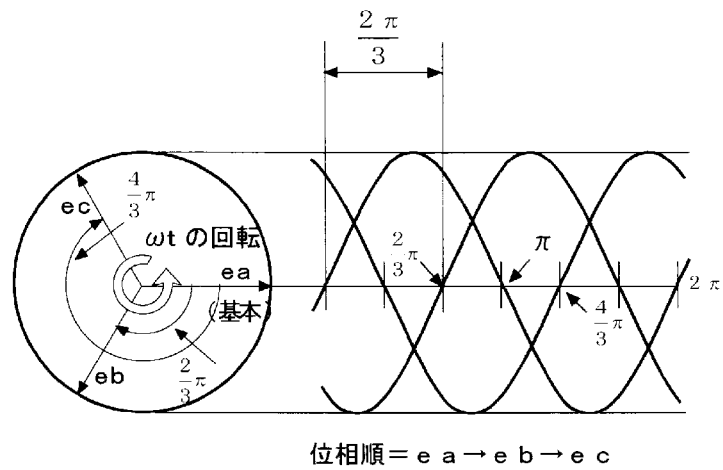
[図14]



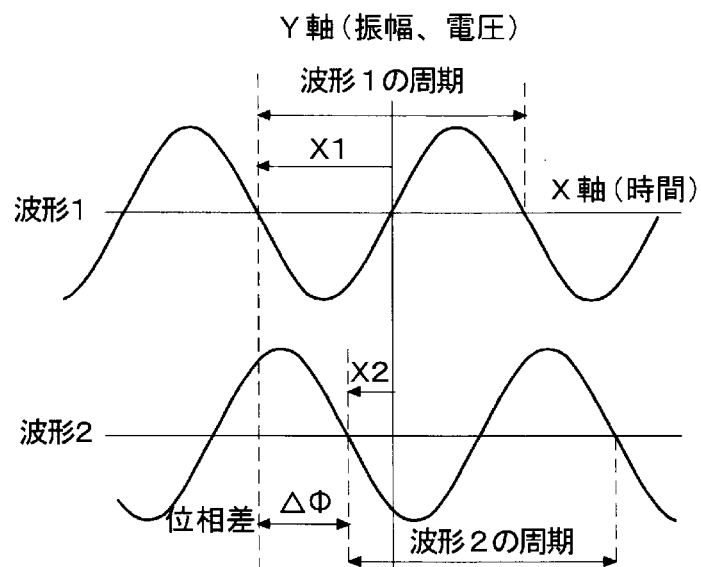
[図15]

$$\Delta \Phi = \frac{4\pi(fd+fdl)}{c} dk$$

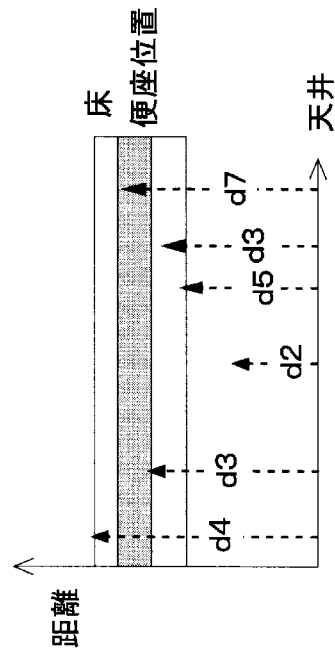
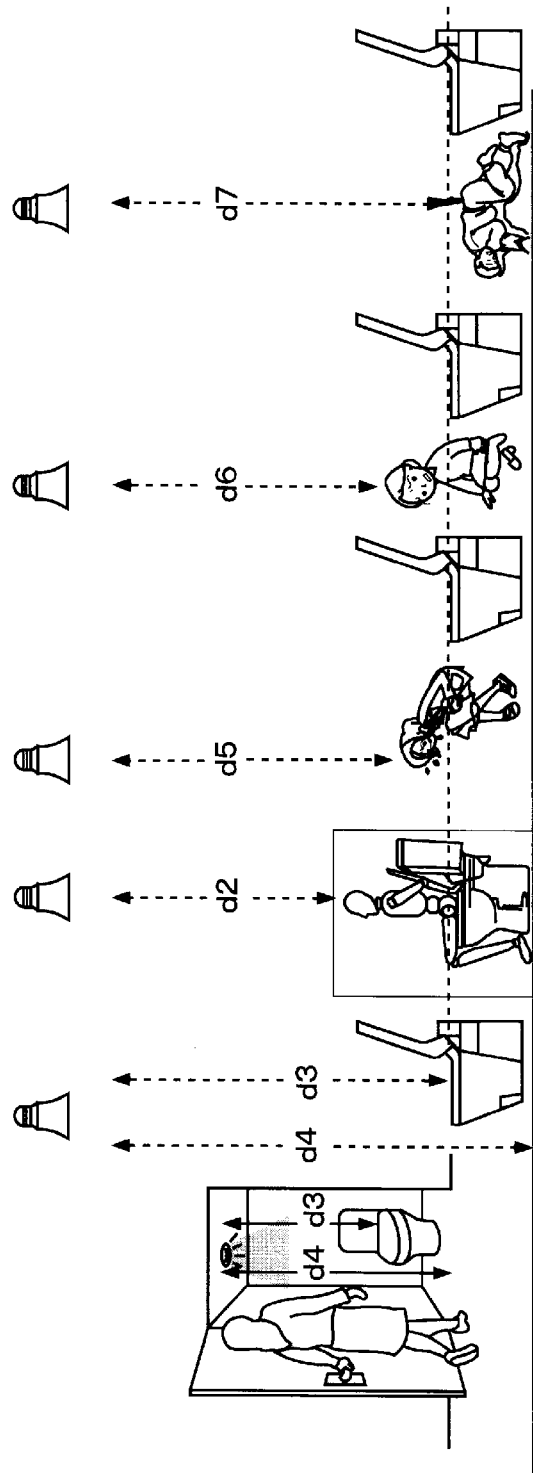
$$dk = \frac{c}{4\pi(fd-fdl)} \Delta \Phi$$



[図16]

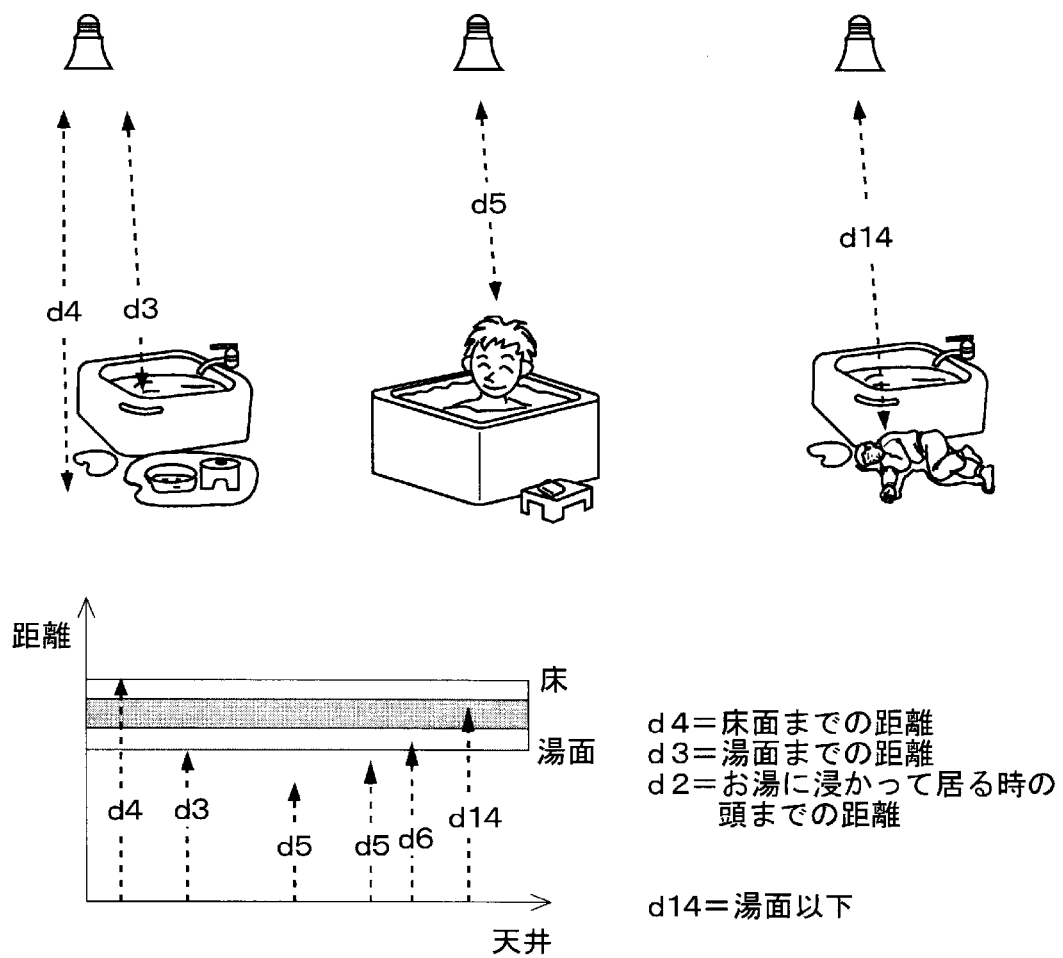


[図17]

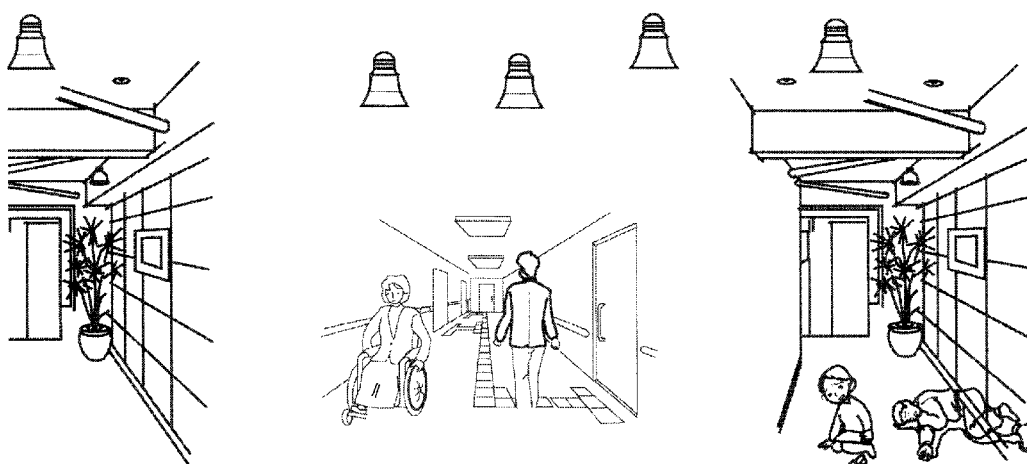


d4=床面までの距離
 d3=便座に座った時の頭までの距離
 d2=便座に座った時の頭までの距離
 d2=かがみ込んだ時の頭までの距離
 d2=転げ落ちた時の頭までの距離
 d7=便座面以下

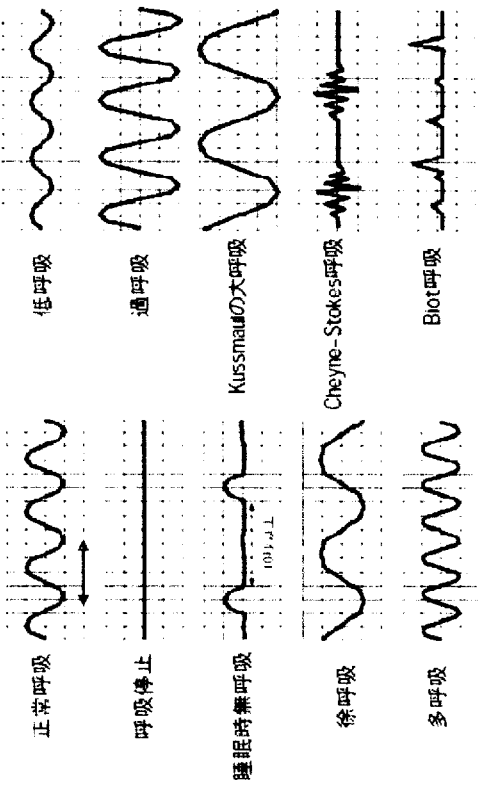
[図18]



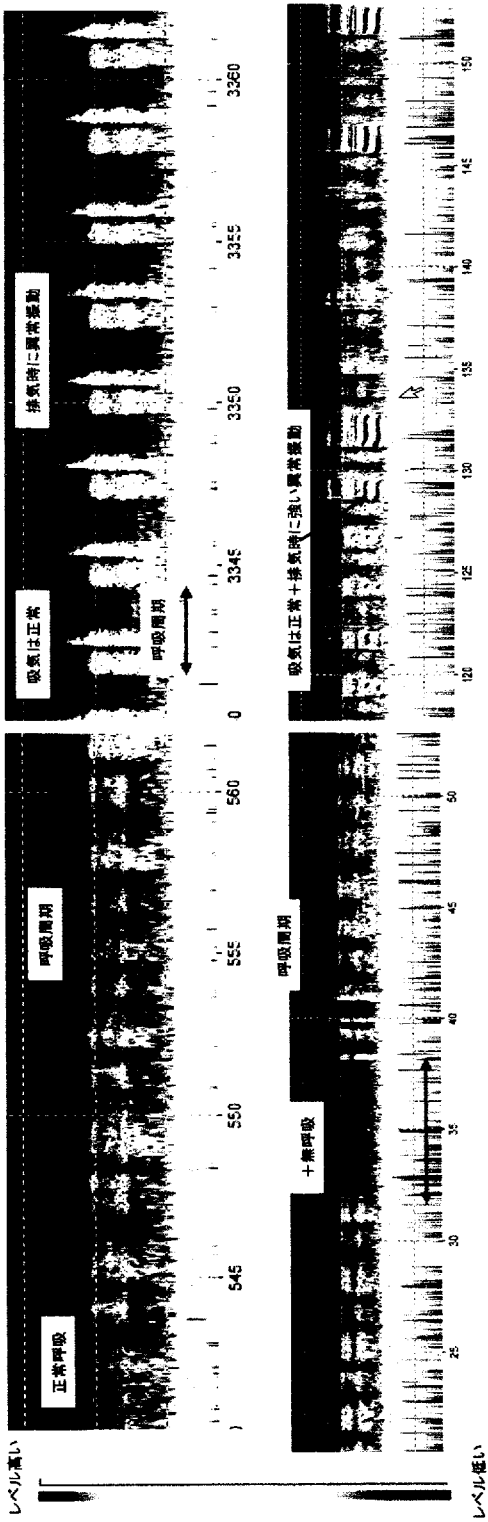
[図19]



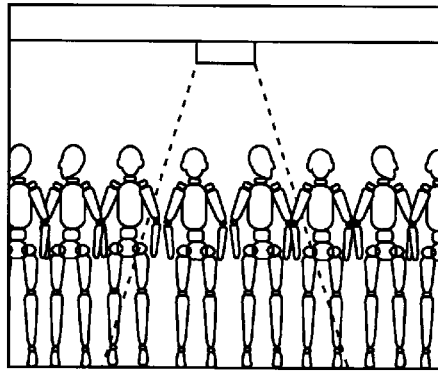
[図20]



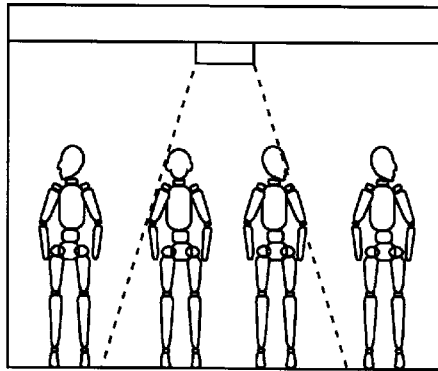
呼吸量の異常	呼吸回数 の異常	減少	無呼吸	呼吸停止・睡眠時無呼吸症候群
		増加	徐呼吸(9回/分以下)	
	一回換気量の異常	減少	頻呼吸(25回/分以上)	表2参照
		増加	低呼吸(低換気)	
		増加	過呼吸(過換気)	
呼吸リズムの異常	周期的な異常	Cheyne-Stokes呼吸	脳疾患・心不全・尿毒症・中毒・各疾患の末期	
	不規則な異常	持続吸気性呼吸		中枢神経系の血管障害・腫瘍・炎症・損傷時 (特に橋や延髄レベルの障害)
		群息呼吸		
		あえぎ呼吸・下嚥呼吸)		
その他	体位の異常	失調性呼吸(Biot呼吸)	心不全・尿毒症	
		起座呼吸		



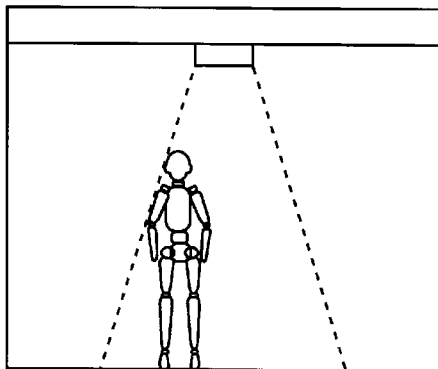
[図21]



(a)

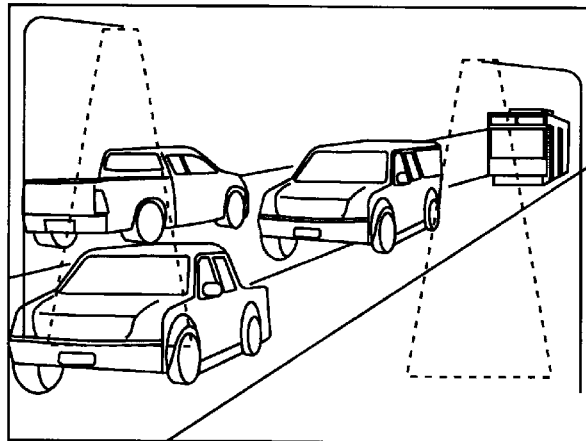


(b)

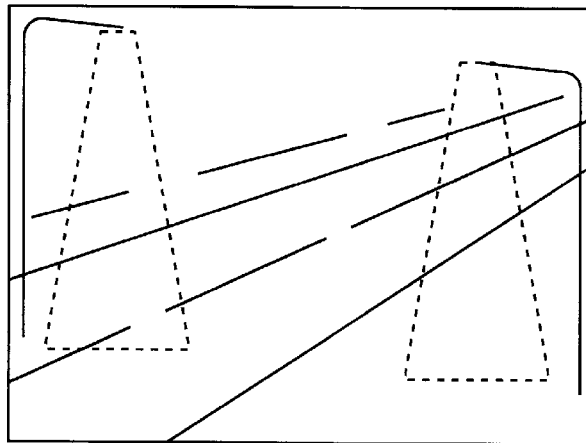


(c)

[図22]

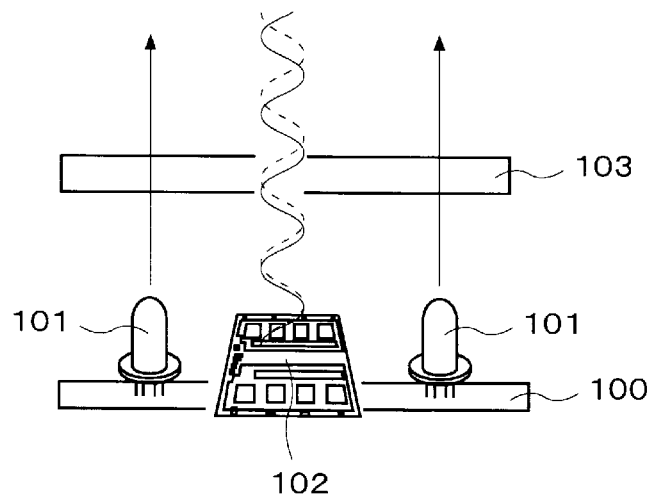


(a)

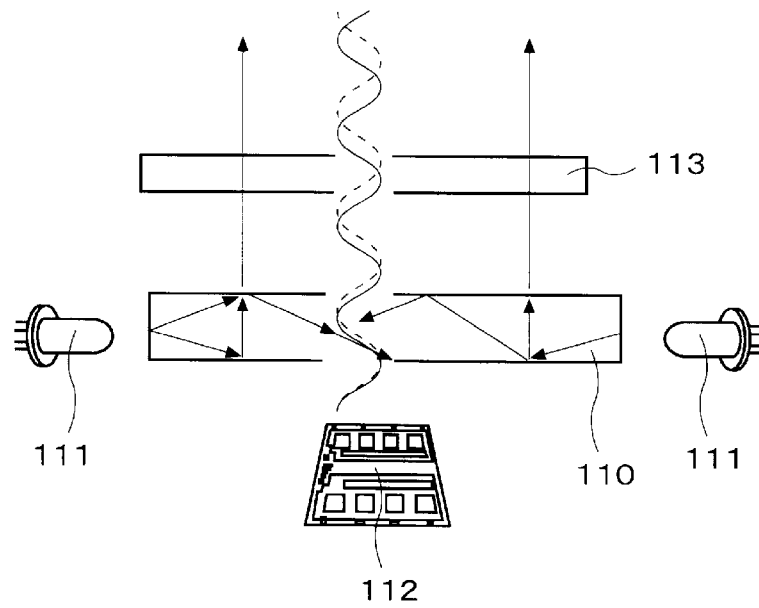


(b)

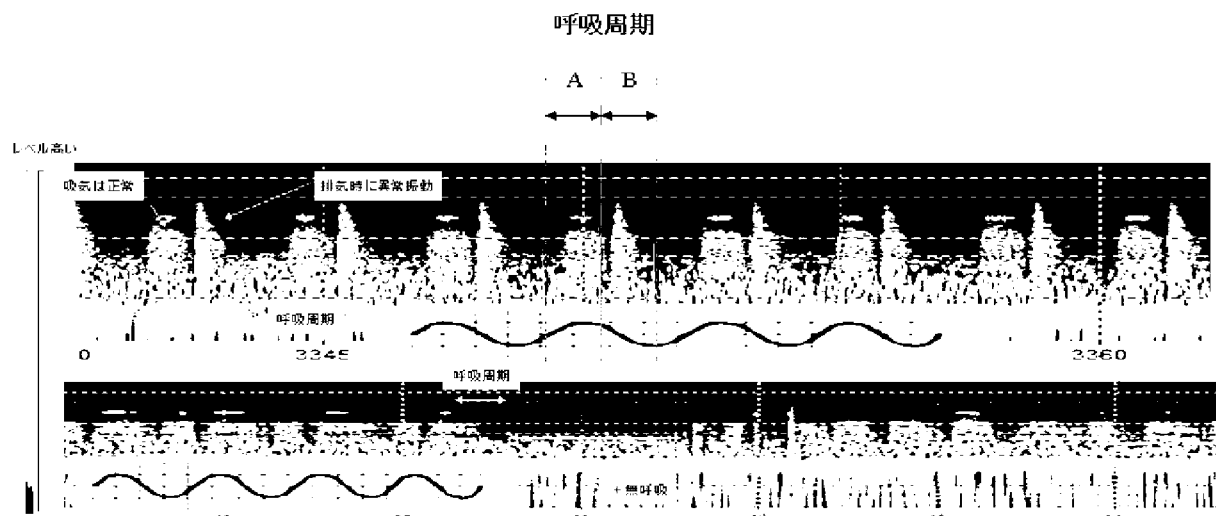
[図23]



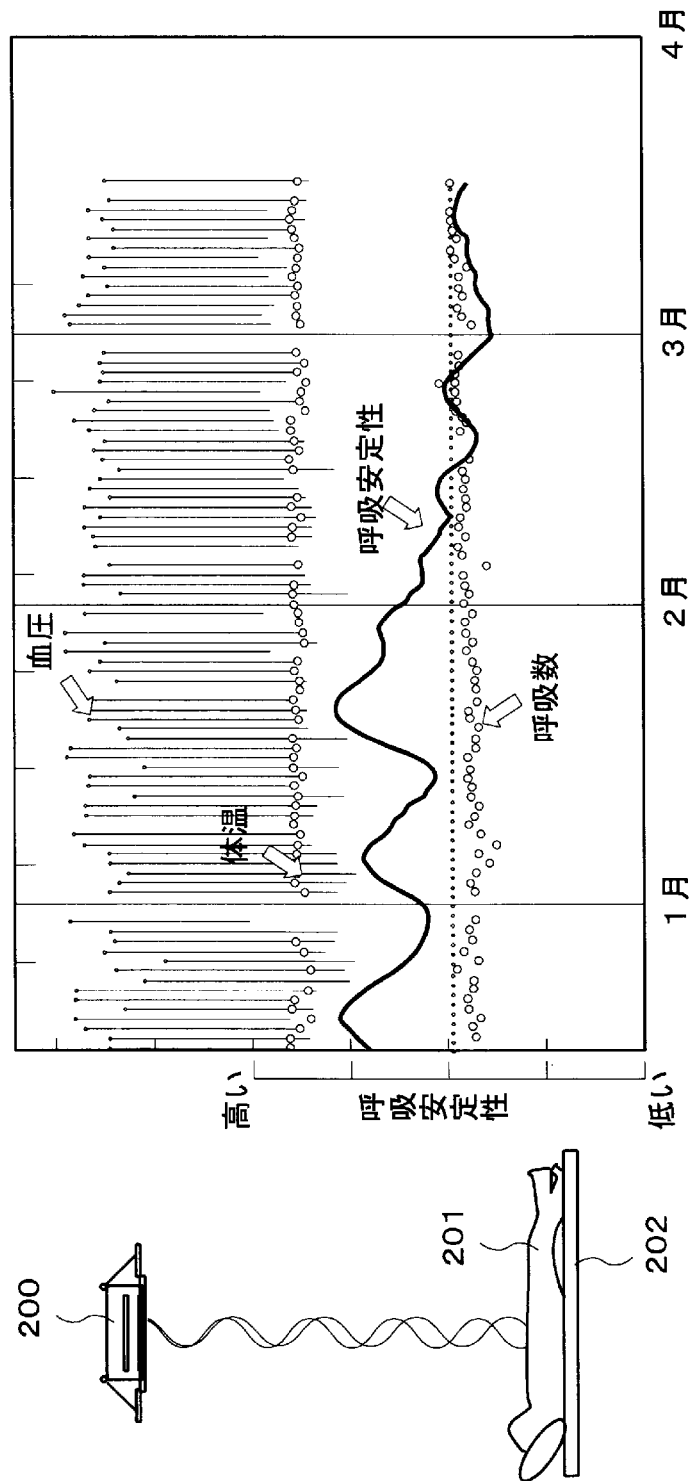
[図24]



[図25]



[図26]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/074299

A. CLASSIFICATION OF SUBJECT MATTER

G01S13/40(2006.01)i, G08B13/16(2006.01)i, A61B5/00(2006.01)n, A61B5/08(2006.01)n, A61B5/107(2006.01)n, A61B5/11(2006.01)n, F21V23/00(2006.01)n

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01S13/00-13/95, G01S7/00-7/51, G01S17/00-17/95, G08B13/16, A61B5/00, A61B5/08-5/117, F21V23/00, F21V33/00, B66B1/00-31/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2009-250661 A (Brother Industries, Ltd.), 29 October 2009 (29.10.2009), paragraphs [0044] to [0129]; fig. 1 to 10 (Family: none)	1,3-10 2
Y A	JP 2005-326345 A (Nohken Inc.), 24 November 2005 (24.11.2005), paragraphs [0080] to [0145]; fig. 1 to 8 & JP 3768511 B2	1,3-10 2
Y A	JP 2006-258467 A (Mitsubishi Electric Corp.), 28 September 2006 (28.09.2006), paragraphs [0011] to [0025]; fig. 1 to 12; paragraphs [0030] to [0033]; fig. 14 to 16 & JP 4555914 B2	1,3-10 2

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance

“E” earlier application or patent but published on or after the international filing date

“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search
13 December, 2012 (13.12.12)

Date of mailing of the international search report
08 January, 2013 (08.01.13)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/074299

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2009-162709 A (IHI Corp.), 23 July 2009 (23.07.2009), paragraphs [0029] to [0033] (Family: none)	1, 3-10 2
Y A	JP 2003-57028 A (Sumitomo Osaka Cement Co., Ltd.), 26 February 2003 (26.02.2003), paragraphs [0028] to [0035]; fig. 7 to 9 (Family: none)	1, 3-10 2
Y A	JP 2009-55997 A (Honda Motor Co., Ltd.), 19 March 2009 (19.03.2009), paragraphs [0015] to [0064]; fig. 1 to 15 (Family: none)	1, 3-10 2
Y A	JP 2011-154993 A (Kabushiki Kaisha Suzuki Engineering), 11 August 2011 (11.08.2011), paragraphs [0033] to [0076]; fig. 1 to 10 (Family: none)	3-10 1, 2
Y A	JP 2010-132444 A (Mitsubishi Electric Corp.), 17 June 2010 (17.06.2010), paragraphs [0008] to [0022]; fig. 1 to 5 (Family: none)	9, 10 1-8
A	JP 9-28681 A (Matsushita Electric Industrial Co., Ltd.), 04 February 1997 (04.02.1997), paragraphs [0075] to [0122]; fig. 1 to 18 (Family: none)	1-10
A	JP 2007-94942 A (Teruya Corp.), 12 April 2007 (12.04.2007), paragraphs [0018] to [0030]; fig. 1 to 4 & JP 4701333 B2	1-10
A	JP 2006-42201 A (Advanced Telecommunications Research Institute International), 09 February 2006 (09.02.2006), paragraphs [0030] to [0105]; fig. 1 to 6 (Family: none)	1-10

A. 発明の属する分野の分類 (国際特許分類 (I P C))

Int.Cl. G01S13/40(2006.01)i, G08B13/16(2006.01)i, A61B5/00(2006.01)n, A61B5/08(2006.01)n, A61B5/107(2006.01)n, A61B5/11(2006.01)n, F21V23/00(2006.01)n

B. 調査を行った分野

調査を行った最小限資料 (国際特許分類 (I P C))

Int.Cl. G01S13/00-13/95, G01S7/00-7/51, G01S17/00-17/95, G08B13/16, A61B5/00, A61B5/08-5/117, F21V23/00, F21V33/00, B66B1/00-31/02

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	1 9 2 2 - 1 9 9 6 年
日本国公開実用新案公報	1 9 7 1 - 2 0 1 2 年
日本国実用新案登録公報	1 9 9 6 - 2 0 1 2 年
日本国登録実用新案公報	1 9 9 4 - 2 0 1 2 年

国際調査で使用した電子データベース (データベースの名称、調査に使用した用語)

C. 関連すると認められる文献

引用文献の カテゴリー*	引用文献名 及び一部の箇所が関連するときは、その関連する箇所の表示	関連する 請求項の番号
Y A	JP 2009-250661 A (ブラザー工業株式会社) 2009. 10. 29, 段落【0044】 - 【0129】, 図1 - 10 (ファミリーなし)	1, 3-10 2
Y A	JP 2005-326345 A (株式会社ノーケン) 2005. 11. 24, 段落【0080】 - 【0145】, 図1 - 8 & JP 3768511 B2	1, 3-10 2

☒ C 欄の続きにも文献が列挙されている。

☐ パテントファミリーに関する別紙を参照。

* 引用文献のカテゴリー

「A」特に関連のある文献ではなく、一般的技術水準を示すもの
「E」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「L」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献 (理由を付す)
「O」口頭による開示、使用、展示等に言及する文献
「P」国際出願日前で、かつ優先権の主張の基礎となる出願

の日の後に公表された文献

「T」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「X」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Y」特に関連のある文献であって、当該文献と他の1以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「&」同一パテントファミリー文献

国際調査を完了した日

1 3 . 1 2 . 2 0 1 2

国際調査報告の発送日

0 8 . 0 1 . 2 0 1 3

国際調査機関の名称及びあて先

日本国特許庁 (I S A / J P)

郵便番号 1 0 0 - 8 9 1 5

東京都千代田区霞が関三丁目4番3号

特許庁審査官 (権限のある職員)

吉田 久

2 S

3 9 0 2

電話番号 0 3 - 3 5 8 1 - 1 1 0 1 内線 3 2 5 8

C (続き) . 関連すると認められる文献		
引用文献の カテゴリー*	引用文献名 及び一部の箇所が関連するときは、その関連する箇所の表示	関連する 請求項の番号
Y A	JP 2006-258467 A (三菱電機株式会社) 2006. 09. 28, 段落【0011】－【0025】, 図1－12, 段落【0030】－【0033】, 図14－16 & JP 4555914 B2	1, 3-10 2
Y A	JP 2009-162709 A (株式会社 I H I) 2009. 07. 23, 段落【0029】－【0033】 (ファミリーなし)	1, 3-10 2
Y A	JP 2003-57028 A (住友大阪セメント株式会社) 2003. 02. 26, 段落【0028】－【0035】, 図7－9 (ファミリーなし)	1, 3-10 2
Y A	JP 2009-55997 A (本田技研工業株式会社) 2009. 03. 19, 段落【0015】－【0064】, 図1－15 (ファミリーなし)	1, 3-10 2
Y A	JP 2011-154993 A (株式会社スズキエンジニアリング) 2011. 08. 11, 段落【0033】－【0076】, 図1－10 (ファミリーなし)	3-10 1, 2
Y A	JP 2010-132444 A (三菱電機株式会社) 2010. 06. 17, 段落【0008】－【0022】, 図1－5 (ファミリーなし)	9, 10 1-8
A	JP 9-28681 A (松下電器産業株式会社) 1997. 02. 04, 段落【0075】－【0122】, 図1－18 (ファミリーなし)	1-10
A	JP 2007-94942 A (株式会社テルヤ) 2007. 04. 12, 段落【0018】－【0030】, 図1－4 & JP 4701333 B2	1-10
A	JP 2006-42201 A (株式会社国際電気通信基礎技術研究所) 2006. 02. 09, 段落【0030】－【0105】, 図1－6 (ファミリーなし)	1-10

Prior Art References for IDS

PCT/JP2012/074299

Our Ref: 12FI015PCT-US

No.	Document Number	Citation	Translation	Prints	CD-R
1	JP2010-066877A	APP1	ABS	full pages	pdf
2	JP3057438B	APP2	ABS	full pages	pdf
3	JP2006-285795A	APP3	ABS	full pages	pdf
4	JP2011-034938A	APP4	ABS	full pages	pdf
5	JP2003-132704A	APP5	ABS	full pages	pdf
6	JP2009-250661A	ISR1	ABS	full pages	pdf
7	JP2005-326345A	ISR2	ABS	full pages	pdf
8	JP2006-258467A	ISR3	ABS	full pages	pdf
9	JP2009-162709A	ISR4	ABS	full pages	pdf
10	JP2003-057028A	ISR5	ABS	full pages	pdf
11	JP2009-055997A	ISR6	ABS	full pages	pdf
12	JP2011-154993A	ISR7	ABS	full pages	pdf
13	JP2010-132444A	ISR8	ABS	full pages	pdf
14	JP09-028681A	ISR9	ABS	full pages	pdf
15	JP2007-094942A	ISR10	ABS	full pages	pdf
16	JP2006-042201A	ISR11	ABS	full pages	pdf

ISR: International Search Report

APP.: Document is discussed on the specification of the subject application

ABS: English-language Abstract

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2010-066877

(43)Date of publication of application : 25.03.2010

(51)Int.Cl.

G08B 25/04 (2006.01)
H04M 11/00 (2006.01)
G08B 21/04 (2006.01)
H04W 4/04 (2009.01)
H04W 84/18 (2009.01)

(21)Application number : 2008-230814

(71)Applicant : MITSUBISHI ELECTRIC
ENGINEERING CO LTD

(22)Date of filing : 09.09.2008

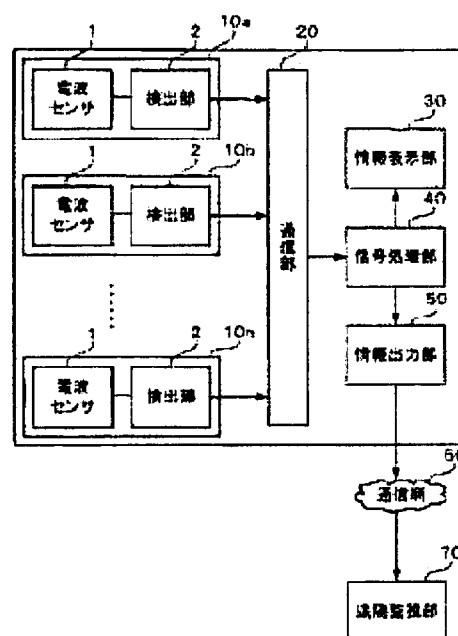
(72)Inventor : NOMURA HIROMORI

(54) RESIDENT MONITORING SYSTEM AND RESIDENT MONITORING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a resident monitoring system which is easily installed in residences to be monitored having various different room layouts, and easily recognizes behavior transition of a resident and the tendency thereof in each living space.

SOLUTION: The resident monitoring system includes: a plurality of sensor parts each having a radio sensor for emitting a radio wave and receiving the reflected wave and a detection part for detecting the amplitude and phase of a signal to be received by the radio sensor, and for acquiring the detection signal; a signal processing part for measuring the current position, motion, respiration rate and cardiac rate of a resident or an animal from the detection signal to be received from the sensor part, and for determining the presence of the resident or the animal; a communication part configuring a network connecting a plurality of sensor parts to the signal processing part; an information display part for displaying the result measured and determined by the signal processing part; an information output part for outputting the result measured and determined by the signal processing part to the outside; and a remote monitoring part for receiving and displaying or notifying the measurement or determination result from the information output part at a remote place.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-083927

(43)Date of publication of application : 28.03.2000

(51)Int.Cl.

A61B 5/08
A61B 5/0245

(21)Application number : 10-276500

(71)Applicant : NIPPON AVIONICS CO LTD

(22)Date of filing : 11.09.1998

(72)Inventor : WAKAMIYA TOSHINARI
FUNADA TORU

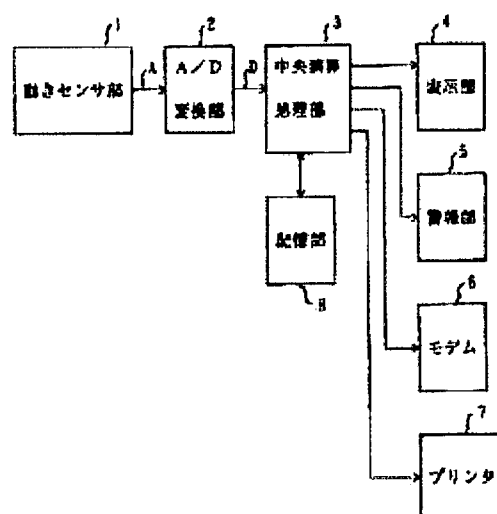
(54) CONTACTLESS TYPE CARDIOPULMONARY FUNCTION MONITOR APPARATUS

(57)Abstract:

PROBLEM TO BE SOLVED: To enable the adequate execution of monitor without retraining an object for monitor by calculating the respiratory rates and cardiac rates to be monitored by signal processing of a movement sensor of a contactless type, comparing and deciding the respiratory rates and heart rates inputted at every specified time and a vital motion manual and generating an alarm by light and sound.

SOLUTION: The movement sensor 1 is installed at a point apart from the object for monitor and the detected movement signal A is inputted as a movement signal D from an A/D conversion section 2 to a central processing section 3. This movement signal D is temporarily saved and a frequency distribution of frequency is determined by executing high-speed Fourier transform in accordance with the saved data. The movement signals after the high-speed Fourier transform are filtered and a respiratory rate graph and heart rate graph are formed. The frequencies of the max.

amplitudes of the respective graphs are determined as the respiratory rates and the heart rates. Further, a vital motion manual is built according to various living patterns. This manual and the respiratory rates and heart rates of very specified time are compared and the alarm is emitted according to the difference and is announced to an announcement destination.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2006-285795

(43)Date of publication of application : 19.10.2006

(51)Int.Cl.

G08B 21/04 (2006.01)
G08B 25/04 (2006.01)

(21)Application number : 2005-106812

(71)Applicant : YAMATAKE CORP

(22)Date of filing : 01.04.2005

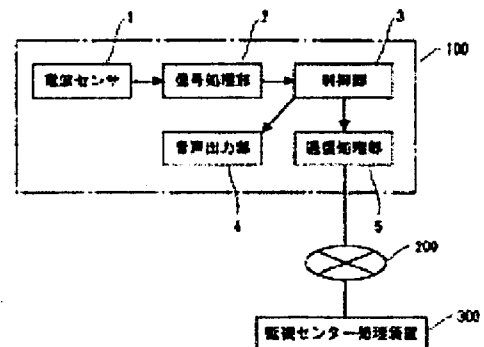
(72)Inventor : HAYASHI TOMOHITO
KANO SHIRO

(54) MONITOR SYSTEM AND METHOD FOR MONITORING RESIDENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a monitor system and a monitor method of a resident, wherein a system installment is simplified, and the presence decision and behavior detection of a resident can be precisely executed.

SOLUTION: This monitor system 100 is installed in a residence, and uses a radio wave sensor 1 for transmitting a transmission wave, and receiving the reflected wave of the transmission wave, and outputting an output signal corresponding to the received reflected wave. A calling signal whose frequency band corresponds to the breath of a resident and a movement signal whose frequency band is higher than that of the calling signal are extracted from a signal outputted by the radio wave sensor 1 by a signal processing part 2. The extracted breath signal and movement signal are inputted to a control part 3. The control part 3 detects the breath signal, and when deciding that the movement of the resident is not recognized in a fixed time or more based on the movement signal, the control part 3 decides that the resident is in an abnormal state.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2011-034938

(43)Date of publication of application : 17.02.2011

(51)Int.Cl.

*F21V 23/00 (2006.01)**F21S 2/00 (2006.01)**F21Y 101/02 (2006.01)*

(21)Application number : 2009-189526

(71)Applicant : GIGA TEC:KK

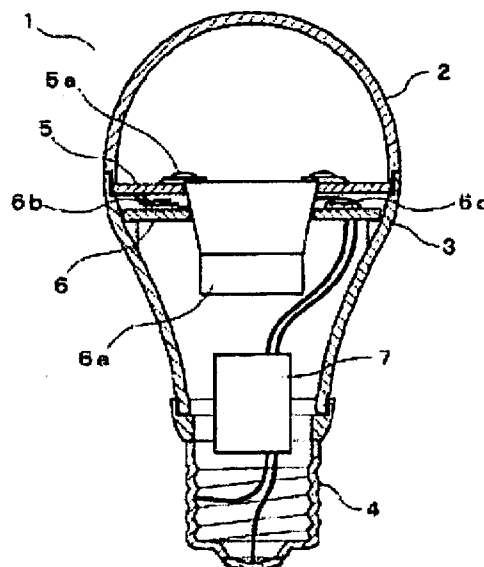
(22)Date of filing : 29.07.2009

(72)Inventor : NAKAZATO MASAHIRO

(54) BULB TYPE LED LIGHTING FIXTURE WITH BUILT-IN DOPPLER SENSOR**(57)Abstract:**

PROBLEM TO BE SOLVED: To provide a bulb type LED lighting fixture with built-in Doppler sensor in which a human body is detected surely, which is energy saving, and in which limitation of a space does not occur only by exchanging bulbs of various incandescent lighting fixtures.

SOLUTION: This lighting fixture body includes a dome cover composed of a translucent material at the upper part of an outer case and a base attachable to a socket of a light bulb at the lower part of the outer case, and has an appearance of a light bulb shape. Inside the illumination fixture body, The lighting fixture body includes: an aluminum substrate equipped with LEDs and a square open part at the center part; below the aluminum substrate, a module substrate which includes the Doppler module to transmit and receive microwaves and carries out lighting control of the LEDs equipped with a time adjusting part and a sensitivity volume; and an AC-DC unit to supply a driving voltage of the module substrate.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-132704

(43)Date of publication of application : 09.05.2003

(51)Int.Cl.

F21S 2/00
F21V 23/04
// F21Y103:025

(21)Application number : 2001-330565

(71)Applicant : OSRAM-MELCO LTD

(22)Date of filing : 29.10.2001

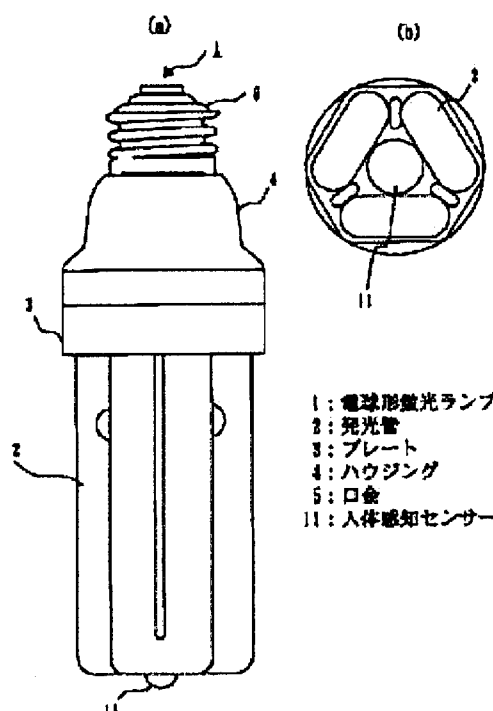
(72)Inventor : KONOMOTO TAKAHIRO
KONDO KAZUYOSHI

(54) ELECTRIC BULB-SHAPED FLUORESCENT LAMP

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain an electric bulb-shaped fluorescent lamp wherein there is no need to mount a human body perception sensor afterwards, further an installation site is not necessary, and furthermore, wiring between the human body perception sensor and a lighting fixture becomes not necessary either because the human body perception sensor is made to be built-in in the lamp.

SOLUTION: In the electric bulb-shaped fluorescent lamp having a light emitting tube constituted by combining plural U-shaped fluorescent lamps and having an inverter for the purpose of lighting this light emitting tube, this is that in which the human body perception sensor to detect the existence of a person is built-in in the light emitting tube in which the plural U-shaped fluorescent lamps are combined.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2009-250661

(43)Date of publication of application : 29.10.2009

(51)Int.Cl. *G01S 13/74 (2006. 01)*
G01S 5/06 (2006. 01)
G06K 17/00 (2006. 01)
H04B 5/02 (2006. 01)
G01S 5/14 (2006. 01)
A61B 5/107 (2006. 01)

(21)Application number : 2008-095981

(71)Applicant : BROTHER IND LTD

(22)Date of filing : 02.04.2008

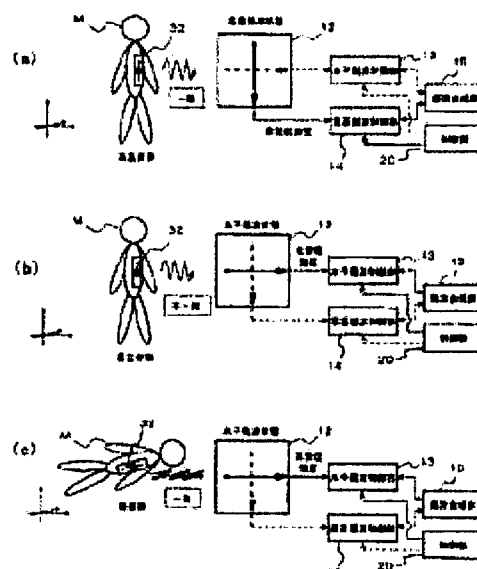
(72)Inventor : INOUE ETSUTERU

(54) MOBILE STATION CONDITION DETECTION SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To estimate the condition of an object in which a mobile station is installed.

SOLUTION: A mobile station tag T includes a tag antenna 32 of which the polarization direction is fixed. A fixed station reader R includes a reader antenna 12 which can generate two polarization planes orthogonal to each other, an arrival time detection section 19 for detecting the reception time of a radio signal, and an RSSI section 17 for detecting reception signal intensity in the two polarization directions, respectively, of the reader antenna 12. A management server S detects the distance from the mobile station tag T to the fixed station reader R on the basis of the reception time detected by the arrival time detection section 19, detects the attitude of the mobile station tag T on the basis of the reception signal intensity in the two polarization directions detected by the RSSI section 17, and determines the condition of the mobile station tag T in accordance with the detection results of the distance and attitude.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2005-326345

(43)Date of publication of application : 24.11.2005

(51)Int.Cl.

G01S 13/40

(21)Application number : 2004-146358

(71)Applicant : NOHKEN:KK

(22)Date of filing : 17.05.2004

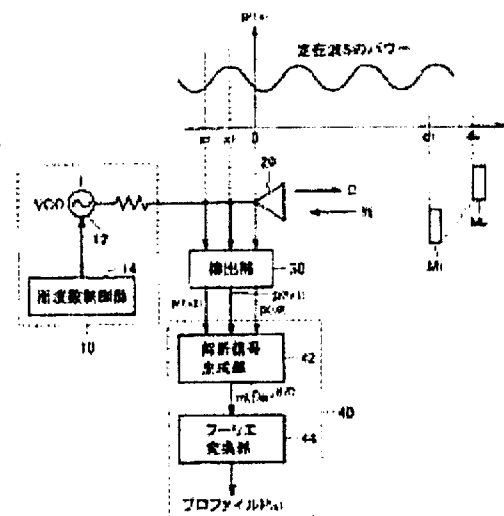
(72)Inventor : UYEYASU TETSUSHI
IRITANI TADAMITSU

(54) DISTANCE-MEASURING DEVICE, DISTANCE-MEASURING METHOD, AND DISTANCE-MEASURING PROGRAM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a distance-measuring device, a distance-measuring method, and a distance-measuring program, which can precisely perform measurement down to short distance, even in a narrow emission frequency band.

SOLUTION: A generation part 12 outputs a signal, having a prescribed transmission frequency f by a frequency control part 14. A transmission part 20 emits electromagnetic waves, having the same frequency f as that of the output signal of the generation part 12 in the measurement axis (x -axis) direction. A detection part 30 includes a plurality of detectors, which are disposed at a plurality of observation points ($x=0$, x_1 , x_2) on the x -axis, respectively. Respective detectors detect the receiving power signals $p(f, 0)$, $p(f, x_1)$, and $p(f, x_2)$ of a standing wave S at the corresponding observation points. An analysis signal generating part 42 extracts constant components, amplitude variation components, and phase variation components from the received power signals $p(f, 0)$, $p(f, x_1)$, and $p(f, x_2)$ and generates analysis signal. A Fourier transformation part 44 performs the Fourier transform of the analysis signal for calculating a profile $P(x)$ and obtains the distance of up to the object to be measured.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2006-258467

(43)Date of publication of application : 28.09.2006

(51)Int.Cl.

G01S 13/40 (2006.01)

(21)Application number : 2005-073065

(71)Applicant : MITSUBISHI ELECTRIC CORP
UNIV OF TOKUSHIMA

(22)Date of filing : 15.03.2005

(72)Inventor : NISHIZAWA HIROSHI
NAKAJIMA TOSHIRO
TAKASHIMA KAZUO
IRITANI TADAMITSU

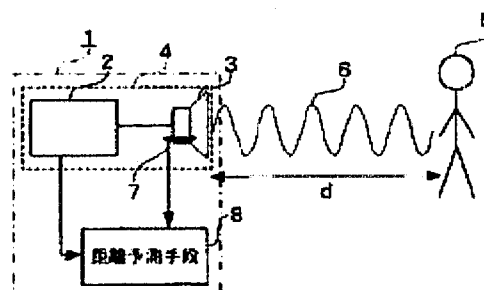
(54) STATIONARY WAVE DISTANCE SENSOR

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a stationary wave distance sensor which can measure the distance to an object to be measured when it is in the stationary state and estimate a position at which the object to be measured will arrive after a lapse of predetermined time when it is on the move stably and with high precision.

SOLUTION: The stationary wave distance sensor comprises a transmitter for transmitting a transmission wave while sweeping the frequency of the transmission wave and a detection means for detecting the amplitude intensity of a stationary wave formed between the transmitter and the object to be measured, measuring the distance from the transmitter to the object to be measured. The transmitter sweeps the frequency of the transmission wave. A distance estimation means is provided which converts the relationship of the amplitude intensity of the stationary wave with the swept frequency into the relationship of the amplitude intensity of the stationary wave with a distance detected

by the Fourier transform and estimates that a distance corresponding to a peak of the amplitude intensity of the stationary wave is a distance from the transmitter to the position at which the object to be measured will arrive after a lapse of predetermined time.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2009-162709

(43)Date of publication of application : 23.07.2009

(51)Int.Cl.

G01S 17/93 (2006. 01)
B25J 19/06 (2006. 01)

(21)Application number : 2008-002853

(71)Applicant : IHI CORP

(22)Date of filing : 10.01.2008

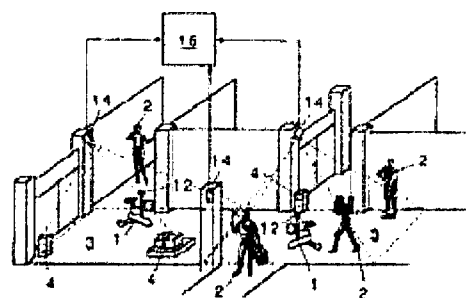
(72)Inventor : TAKANO TAKETOSHI
MURAKAMI HIROKI

(54) SURVEILLANCE DEVICE FOR MOBILE ROBOT AND SURVEILLANCE METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a surveillance device for mobile robot and a surveillance method capable of reliably identifying a person and a mobile robot even when the size and the velocity of the mobile robot is at the same levels as the person when the person and the mobile robot move in the same area and capable of securing human safety without an operator in charge of surveillance even when a safety function of the mobile robot malfunctions.

SOLUTION: The surveillance device for mobile robot includes a reflector 12 attached to the mobile robot 1 and strongly reflecting a laser beam, a three-dimensional laser radar 14 three-dimensionally measuring a moving area of the mobile robot, and a robot restraint device 16 identifying the mobile robot and a person from the measurement results by the three-dimensional laser radar and restraining the mobile robot from operating when the relative distance between the person and the mobile robot is smaller than a prescribed threshold.



(11)Publication number : 2003-057028
(43)Date of publication of application : 26.02.2003

(72)Inventor : TAKEI TOSHIJI
TAKEMURA YASUHIRO
MIMURA KAZUHIRO
KATO KEI

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2009-055997

(43)Date of publication of application : 19.03.2009

(51)Int.Cl.

A61B 5/11 (2006.01)
 A61B 5/0245 (2006.01)
 A61B 5/08 (2006.01)
 A61B 10/00 (2006.01)

(21)Application number : 2007-224060

(71)Applicant : HONDA MOTOR CO LTD
KYUSHU UNIV

(22)Date of filing : 30.08.2007

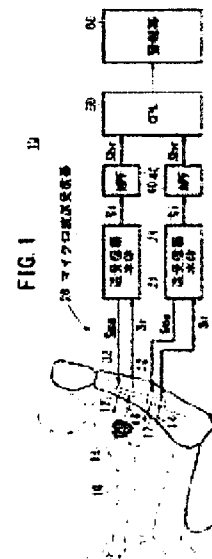
(72)Inventor : MASE ATSUSHI
TATEISHI NAONORI
NISHIYAMA KEISUKE
SHIRAKATA TETSURO
YOSHIDA TAKASHI

(54) BIOLOGICAL VIBRATION FREQUENCY DETECTOR AND VEHICLE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a biological vibration frequency detector with high accuracy and a vehicle provided with the biological vibration frequency detector.

SOLUTION: A heart rate detector 10 is provided with a plurality of microwave transmitter-receivers 20 for irradiating a subject 16 with microwaves 12 and receiving the reflected waves 14, and a CPU 50 for executing correlation processing using heart rate signals Shr based on the plurality of reflected waves 14 and detecting the heart rate [times/minute] of the subject 16 using the processing result. Thus, the heart rate HR can be detected using the result of correlation. Thus, even when one of the reflected waves 14 includes noise, it is made possible to reduce the influence of the noise, so that the detection accuracy of the heart rate HR is improved.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2011-154993

(43)Date of publication of application : 11.08.2011

(51)Int.Cl. *F21V 33/00 (2006.01)*
F21S 2/00 (2006.01)
F21V 19/00 (2006.01)
F21Y 101/02 (2006.01)

(21)Application number : 2010-180385

(71)Applicant : SUZUKI ENGINEERING:KK

(22)Date of filing : 11.08.2010

(72)Inventor : SUZUKI KIMIO

(30)Priority

Priority number : 2009297239

Priority date : 28.12.2009

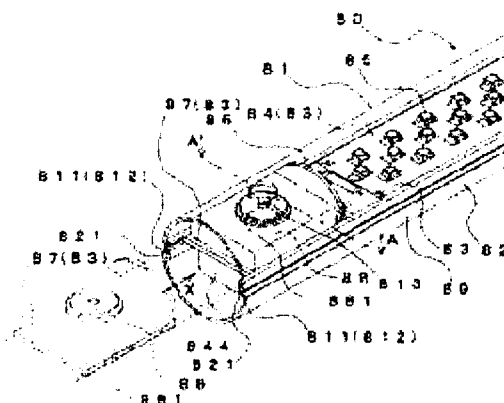
Priority country : JP

(54) LED ILLUMINATION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To enable illumination, prevention of crimes or the like, or monitoring inside various kinds of facilities such as stores or the like.

SOLUTION: An LED illumination device 80 is provided, in which inside a cylindrical member 89 that is formed by linkage of a semi-transparent resin cover 81 and an aluminum chassis 82, a substrate part 83 that is composed of an LED substrate 84 and a camera substrate 87 is built in. In the LED substrate 84, a plurality of LEDs 85 are arranged on the side opposing to the semi-transparent resin cover 81, while a power supply substrate 845 is arranged on the side opposing to the aluminum-chassis 82, and a power supply unit (AC-DC converter) 844 is arranged on the power supply substrate 845. In the camera substrate 87, a camera unit 88 is arranged on the side opposing to the semi-transparent resin cover 81, while on the side opposing to the aluminum-chassis 82, a video-signal forming circuit in which an image photographed by the camera unit 88 is formed into a video signal, and a transmission substrate 871 by which the video signals are transmitted are arranged, and a light shielding plate 86 is installed between the LED substrate 84 and the camera substrate 87.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2010-132444

(43)Date of publication of application : 17.06.2010

(51)Int.Cl. B66B 31/00 (2006. 01)
B66B 27/00 (2006. 01)

(21)Application number : 2008-312323 (71)Applicant : MITSUBISHI ELECTRIC CORP

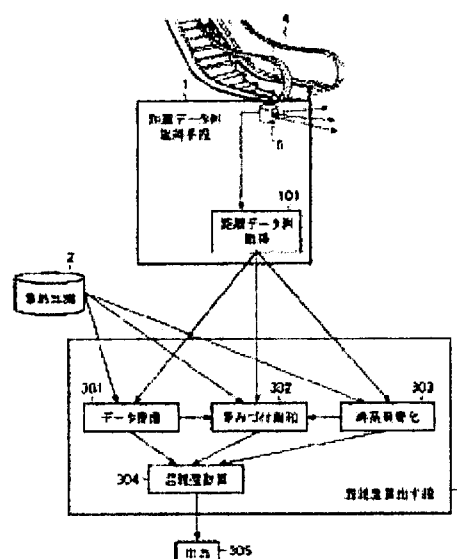
(22)Date of filing : 08.12.2008 (72)Inventor : HAYASHI KENTARO
HIRAI TAKAHIDE
TSUTADA HIROYUKI
SHINDOI MASARU
TAKEUCHI KOICHI

(54) PASSENGER DETECTING DEVICE FOR PASSENGER CONVEYER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a passenger detecting device for a passenger conveyor, capable of efficiently and accurately detecting even at a few measuring points.

SOLUTION: A distance data row acquiring means 1 outputs a measuring result as a distance data row by measuring the distance to passengers in the vicinity of a boarding-alighting port in a passenger conveyor by radiating a beam in a plurality of directions by a distance measuring sensor 5. A crowded degree calculating means 3 determines the data density 301 and the time series change 303 of the passengers from the distance data row using the prior knowledge 2 indicating a weighting value, and calculates the crowded degree of the passengers by making a crowded degree calculation 304 based on these data by determining the weighting sum total 302.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-028681

(43)Date of publication of application : 04.02.1997

(51)Int.Cl.

A61B 5/00
 A61B 5/00
 A61B 5/0205
 A61B 5/107
 A61G 12/00
 G08B 25/04
 G08C 15/00
 H04M 11/00

(21)Application number : 07-178488

(71)Applicant : MATSUSHITA ELECTRIC IND CO LTD

(22)Date of filing : 14.07.1995

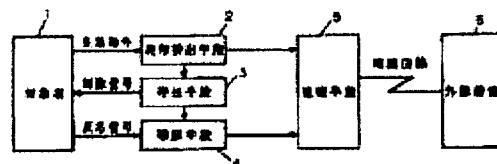
(72)Inventor : SHIMADA TAKUO
 YAMAUCHI YOSHIYUKI
 TAKAHASHI HIDEKI
 TANAKA EIICHI
 YAMAMOTO TERUO

(54) SAFETY CONFIRMING SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To inspect a safety of a single aged person, etc., in house and to inform only when something unusual is happened.

SOLUTION: False signals from a safety confirming system is reduced by accurately confirming the condition of the safety of a subject 1 before a signal is sent, due to installing a means of calling 3 for calling the subject 1 by stimulation of sound, vibration or light when a disorder is detected from an action or a signal from the organism of the subject 1 and a means of confirming 4 for confirming a reaction of the subject 1 against the stimulation.



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2007-094942

(43)Date of publication of application : 12.04.2007

(51)Int.Cl.	<i>G06Q</i>	<i>50/00</i>	<i>(2006. 01)</i>
	<i>G08B</i>	<i>25/10</i>	<i>(2006. 01)</i>
	<i>G08B</i>	<i>25/04</i>	<i>(2006. 01)</i>
	<i>G06Q</i>	<i>10/00</i>	<i>(2006. 01)</i>
	<i>G08C</i>	<i>17/00</i>	<i>(2006. 01)</i>
	<i>G06K</i>	<i>19/07</i>	<i>(2006. 01)</i>
	<i>G06K</i>	<i>19/00</i>	<i>(2006. 01)</i>
	<i>G06K</i>	<i>17/00</i>	<i>(2006. 01)</i>
	<i>H04B</i>	<i>5/02</i>	<i>(2006. 01)</i>
	<i>H04B</i>	<i>7/15</i>	<i>(2006. 01)</i>
	<i>H04B</i>	<i>1/59</i>	<i>(2006. 01)</i>
	<i>A61G</i>	<i>12/00</i>	<i>(2006. 01)</i>

(21)Application number : 2005-286206

(71)Applicant : TERUYA:KK
 PEGASUS NET KK
 SUGIYAMA HIROICHI

(72)Inventor : SUGIYAMA AKINARI
 SHINOI AKIRA
 SUGIYAMA HIROICHI
 SAITO TOSHIYUKI
 HASHIMOTO SATORU
 YABUSAKI KAZUMI
 SUZUKI TERUTAKA
 YAMAGUCHI TAKASHI
 AKITANI TOMOMI

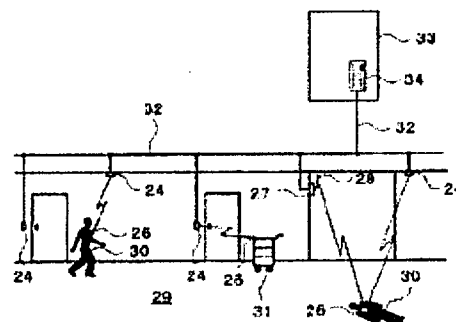
(22)Date of filing : 30.09.2005

(54) MOVING OBJECT MONITORING SYSTEM IN HOSPITAL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a moving object monitoring system in a hospital for making a quick and reliable response to detected abnormality on a patient, delivery mistakes of medicines, or the like.

SOLUTION: In the moving object monitoring system, a patient possesses an RFID tag with remote communication function comprising: an RFID tag 26 capable of radio communication with a reader 24 without batteries; an RF communication module capable of radio communication with a radio base station by transmitting radio wave by itself; a means capable of inputting contact point signal and/or sensor signal to the RFID chip constituting the RFID tag; and a means for including a light emitting element and/or sounding element in the RF communication module to output warning. The tag is mounted on a wagon 31 on which a medicine tray is placed, the reader is arranged at a plurality of points, such as passages and rehabilitation courses, inside and outside a ward, and the radio base station is arranged at one point or more, to connect the reader and the radio base station to a server at a nurse station or in a management center by way of a LAN or power line carrier communication.



one point or more, to connect the reader and the radio base station to a server at a nurse station or in a management center by way of a LAN or power line carrier communication.

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2006-042201

(43)Date of publication of application : 09.02.2006

(51)Int.Cl. H04Q 7/34 (2006. 01)
G01S 11/02 (2006. 01)

(21)Application number : 2004-222442

(71)Applicant : ADVANCED TELECOMMUNICATION
RESEARCH INSTITUTE
INTERNATIONAL

(22)Date of filing : 29.07.2004

(72)Inventor : WATANABE MASAHIRO

(54) DISTANCE MEASUREMENT SYSTEM, DISTANCE MEASURING METHOD AND COMMUNICATION EQUIPMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a distance measurement system and a distance measuring method for measuring distance between radio terminals, with a simple constitution and at a low cost, and to provide communication equipment.

SOLUTION: First carrier waves having first frequency f_1 and second carrier waves having second frequency f_2 are transmitted from a transmitter provided on one mobile terminal to the other mobile terminal. The first and second carrier waves transmitted from one mobile terminal are received by a receiver provided on the other mobile terminal and phase difference $\Delta\psi$ between the first and second carrier waves is detected. Furthermore, distance R between one mobile terminal and the other mobile terminal is calculated based on the detected phase difference $\Delta\psi$, the first frequency f_1 and the second frequency f_2 .

