US 20140167959A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2014/0167959 A1**

(43) **Pub. Date: Jun. 19, 2014**

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(54) **FIRE DETECTOR HAVING BEACON MODULE FORINDOOR POSITIONING, AND INDOOR POSITIONINGSYSTEM USING THE SAME**

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(21) Appl. No.: **13/773,374**

(22) Filed: **Feb. 21, 2013**

(30) **Foreign Application Priority Data**

Dec. 14, 2012 (KR) 10-2012-0146087

Publication Classification

(51) **Int. Cl.**
G01S 1/04 (2006.01)

(52) **U.S. Cl.**
CPC ***G01S 1/04*** (2013.01)
USPC **340/539.26**

(57) **ABSTRACT**

A fire detector having a beacon module for indoor positioning and an indoor positioning system using the same are provided. The fire detector includes a power supply unit, an AC/DC converter, an indoor positioning beacon module, and a fire detection unit. The power supply unit receives an input of a power source and supplies the power source. The AC/DC converter converts the power source and supplies a driving power source. Upon fire occurrence or periodically, the indoor positioning beacon module wireless transmits a beacon signal including a beacon ID through a built-in antenna. The fire detection unit detects fire occurrence or non-occurrence.

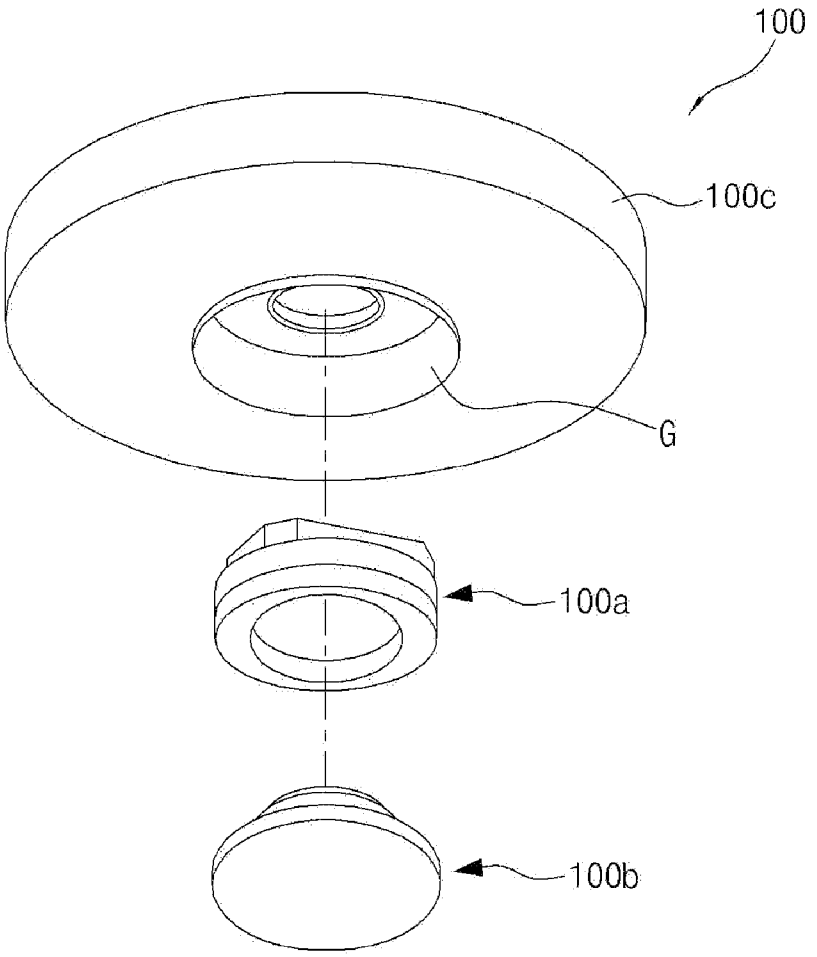


FIG. 1

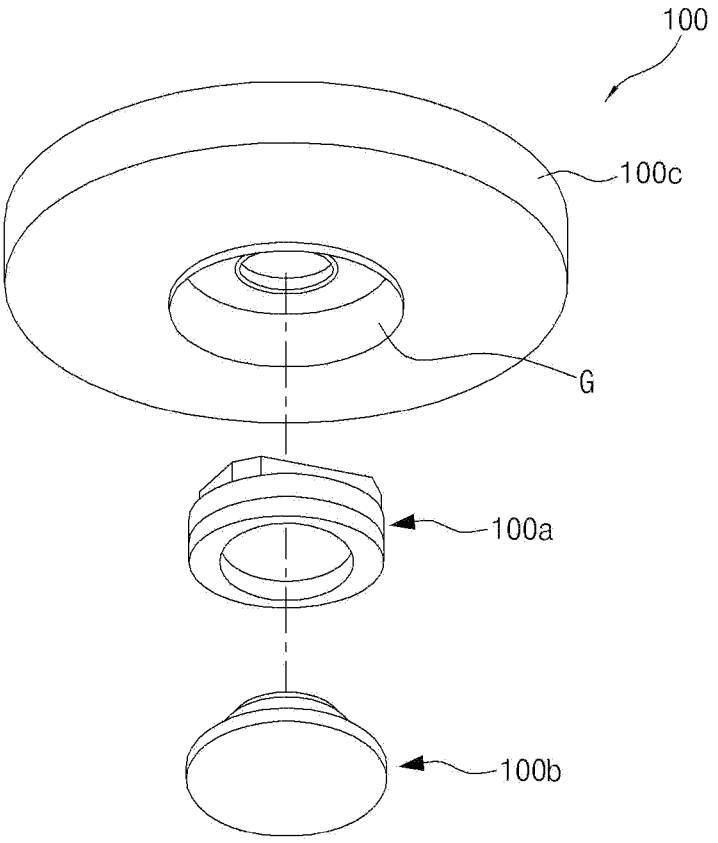


FIG. 2

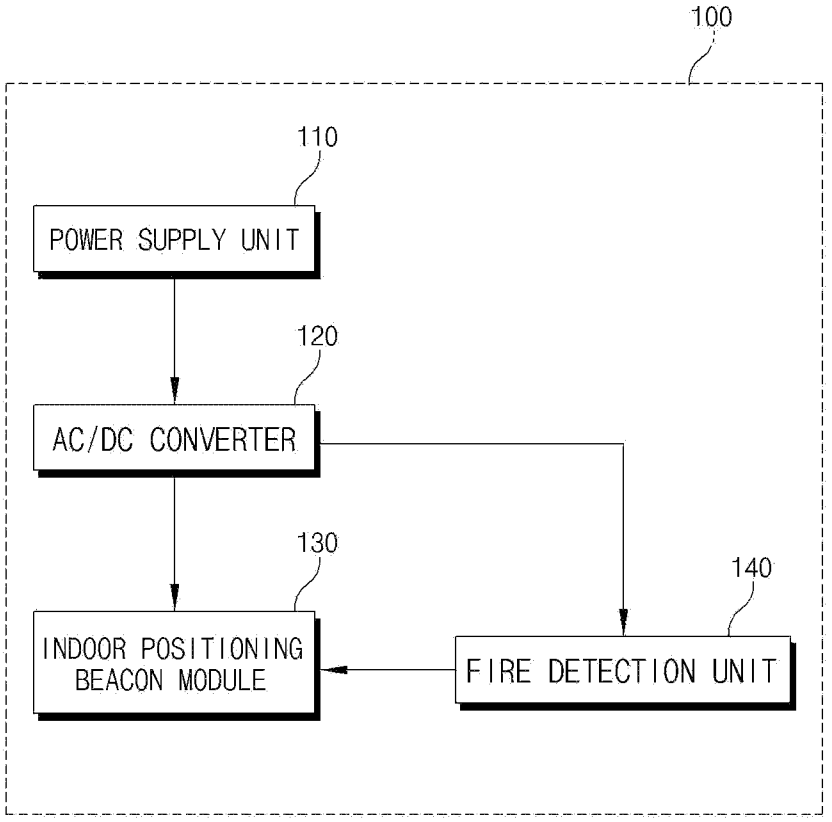

100
110
POWER SUPPLY UNIT
120
AC/DC CONVERTER
130
INDOOR POSITIONING BEACON MODULE
140
FIRE DETECTION UNIT

FIG. 3

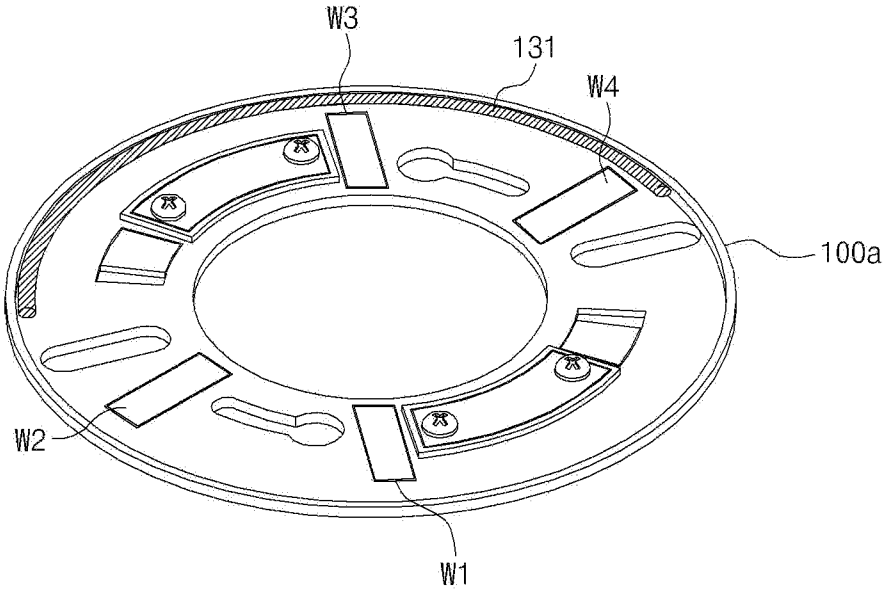
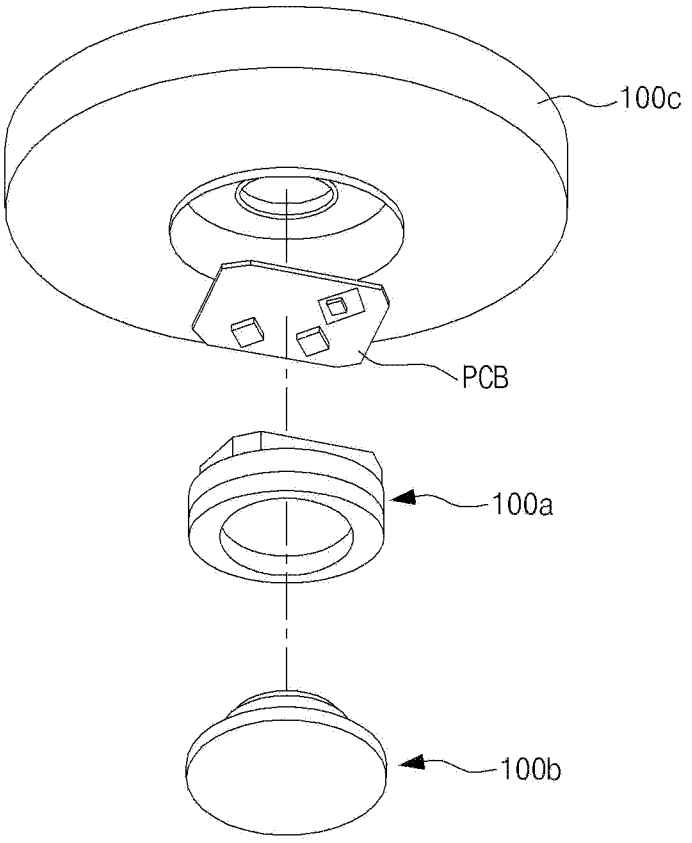


FIG. 4



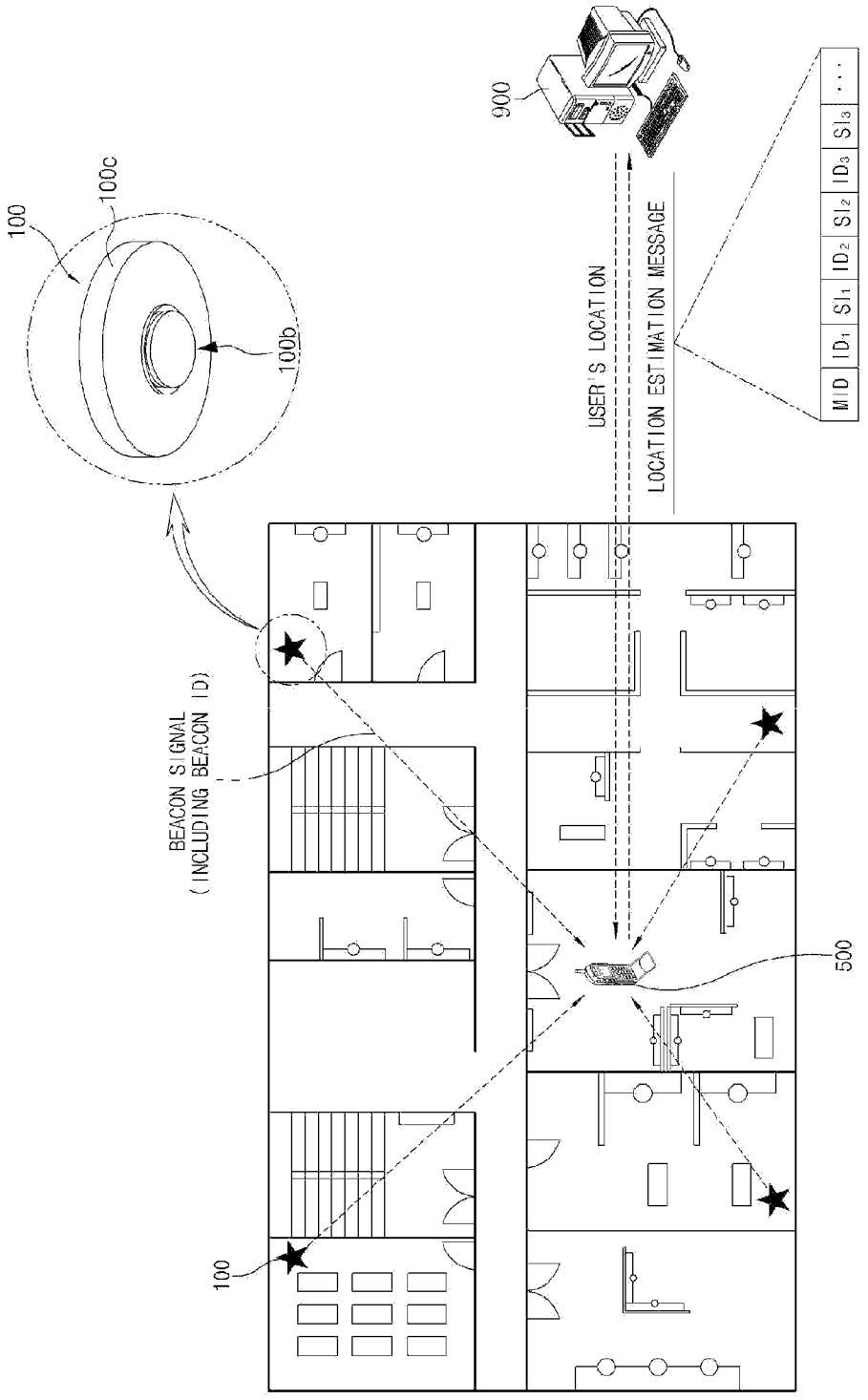

900
100
100c
100b
USER'S LOCATION
LOCATION ESTIMATION MESSAGE
MID | ID1 | SI1 | ID2 | SI2 | ID3 | SI3 | ...
BEACON SIGNAL
(INCLUDING BEACON ID)
500
100

FIG. 5

FIRE DETECTOR HAVING BEACON MODULE FORINDOOR POSITIONING, AND INDOOR POSITIONINGSYSTEM USING THE SAME

CROSS REFERENCES

[0001] This application claims the benefit of Korean Patent Application No. 10-2012-0146087, filed 14 Dec. 2012, which is hereby incorporated by reference in its entirety into this application.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a fire detector having a beacon module for indoor positioning, and an indoor positioning system using the same. More particularly, the present invention relates to a technology capable of simply building an indoor positioning system at a low cost, by installing a beacon module for indoor positioning in a fire detector to make accurate indoor positioning possible.

[0004] 2. Description of the Related Art

[0005] In recent years, an initial Global Positioning System (GPS) technology developed for military use is being widely used for civilian purposes of navigation, measurement, cartography and the like. Also, even a Location Based Service (LBS) using a GPS receiver as a positioning sensor has been commercialized.

[0006] But, it frequently occurs that the GPS receiver cannot receive a GPS satellite signal within doors, a metropolitan area of many high-rise buildings, an underground parking lot, a subway, a tunnel and the like. For this reason, there is a problem that the GPS receiver cannot provide consecutive user location information to a user indoors.

[0007] To fix this problem, many researches have been made on an indoor positioning technology of installing an Access Point (AP) within a building and enabling the AP to locate a target within doors using a Radio Frequency (RF) signal, and a service based on this. Active researches have been made on wireless indoor positioning technologies using infrared rays, ultrasonic waves and the like in addition to the RF signal.

[0008] The RF signal based indoor positioning technology is a technology of locating a target through a relative Received Signal Strength Indication (RSSI) received from a previously installed access point. The infrared ray based indoor positioning technology is a technology in which infrared sensors installed throughout the indoor recognize an infrared device having a unique IDentifier (ID) code and locate the infrared device. The ultrasonic wave based indoor positioning technology is a technology of locating a target using a transfer rate difference between a fast RF signal and a relative slow ultrasonic wave.

[0009] However, the aforementioned indoor positioning technologies excepting the ultrasonic wave based indoor positioning technology have a disadvantage of generally not only causing a large measurement error but also requiring very many access points, infrared sensors or the like. Also, because even an error of positioning information measurement is great more than a few meters, many inconveniences of use are caused.

[0010] Owing to the characteristic in which an RF signal is difficult to permeate walls, in many cases, the RF signal based indoor positioning technology is difficult to detect an accurate current location of a user within doors and is also difficult to detect an accurate location of the user between floors. Further, owing to a limitation on a basic reception distance of infrared rays, the infrared ray based indoor positioning technology has a problem that service is restrictive, and the cost of system installation and maintenance is very high. Further, the ultrasonic wave based indoor positioning technology enables accurate measurement, but has a problem that the cost of system installation is very high.

[0011] That is, the conventional indoor positioning technologies have a problem of having to bear the investment cost for expensive system building, because they cannot implement indoor positioning if an expensive indoor positioning system is not equipped.

SUMMARY OF THE INVENTION

[0012] An aspect of exemplary embodiments of the present invention is to address at least the problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of exemplary embodiments of the present invention is to simply build an indoor positioning system at a low cost, by installing a beacon module for indoor positioning in a fire detector to make accurate indoor positioning possible.

[0013] According to one aspect of the present invention, a fire detector is provided. The fire detector has a cover formed to cover a bottom surface of a base, and the base coupled to the cover to form a smoke detection room and concurrently form a dark room inside. The fire detector includes a power supply unit, an Alternating Current/Direct Current (AC/DC) converter, an indoor positioning beacon module, and a fire detection unit. The power supply unit receives an input of a power source from the external and supplies the power source to the AC/DC converter. The AC/DC converter converts the power source supplied from the power supply unit and supplies a driving power source to the indoor positioning beacon module. Upon fire occurrence or periodically, the indoor positioning beacon module wireless transmits a beacon signal including a beacon ID to the external through a built-in antenna. The fire detection unit detects fire occurrence or non-occurrence.

[0014] The power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit may be installed in predetermined positions of the base. The base may have a plurality of grooves for installing the power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit.

[0015] The indoor positioning beacon module may be installed at the top within doors and may be provided in a circuit board between a support supporting a structure of the fire detector and the base.

[0016] According to another aspect of the present invention, an indoor positioning system includes at least one or more fire detectors, a portable terminal, and a positioning server. The at least one or more fire detectors each have an indoor positioning beacon module for, upon fire occurrence or periodically, wireless transmitting a beacon signal comprising a beacon IDentifier ID to the external through a built-in antenna. The portable terminal receives a beacon signal from the fire detector located around the portable terminal through wireless communication, extracts a beacon ID from the received beacon signal, detects a strength of the beacon signal, and stores the extracted beacon ID and the detected strength of the beacon signal in a memory, and, upon fire occurrence or periodically, includes each of the beacon ID

and signal strength stored in the memory in a location estimation message and wireless transmits the location estimation message to the external. The positioning server receives the location estimation message from the portable terminal through the wireless communication, determines a location of a user who carries the portable terminal on the basis of information comprised in the received location estimation message, maps the determined location of the user on a map, and wireless transmits the mapped location to the portable terminal.

[0017] The fire detector may have a cover formed to cover a bottom surface of a base, and the base coupled to the cover to form a smoke detection room and concurrently form a dark room inside. The positioning system may include includes a power supply unit, an AC/DC converter, an indoor positioning beacon module, and a fire detection unit. The power supply unit receives an input of a power source from the external and supplies the power source to the AC/DC converter. The AC/DC converter converts the power source supplied from the power supply unit and supplies a driving power source to the indoor positioning beacon module. Upon fire occurrence or periodically, the indoor positioning beacon module wireless transmits a beacon signal including a beacon ID to the external through a built-in antenna. The fire detection unit detects fire occurrence or non-occurrence.

[0018] In the fire detector, the power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit may be installed in predetermined positions of the base, and the base may have a plurality of grooves for installing the power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit.

[0019] In the fire detector, the indoor positioning beacon module may be installed at the top within doors and may be provided in a circuit board between a support supporting a structure of the fire detector and the base.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

[0021] FIGS. **1** and **2** are diagrams illustrating a fire detector according to an exemplary embodiment of the present invention;

[0022] FIG. **3** is a diagram illustrating a shape of a base of a fire detector according to an exemplary embodiment of the present invention;

[0023] FIG. **4** is a diagram illustrating a fire detector according to another exemplary embodiment of the present invention;

[0024] FIG. **5** is a diagram illustrating an indoor positioning system according to an exemplary embodiment of the present invention.

[0025] Throughout the drawings, the same drawing reference numerals will be understood to refer to the same elements, features and structures.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Exemplary embodiments of the present invention will now be described in detail with reference to the annexed drawings.

[0027] In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0028] FIGS. **1** and **2** are diagrams illustrating a fire detector according to an exemplary embodiment of the present invention. FIG. **3** is a diagram illustrating a shape of a base of a fire detector according to an exemplary embodiment of the present invention. FIG. **4** is a diagram illustrating a fire detector according to another exemplary embodiment of the present invention.

[0029] Referring to FIGS. **1** and **2**, the fire detector **100** according to an exemplary embodiment of the present invention includes a base **100***a*, a cover **100***b*, and a support **100***c*. A power supply unit **110**, an Alternating Current/Direct Current (AC/DC) converter **120**, an indoor positioning beacon module **130**, and a fire detection unit **140** are provided in predetermined positions of the base **100***a*.

[0030] The base **100***a* is coupled with a cover **100***b* to form a smoke detection room and concurrently form a dark room within the inside. That is, the base **100***a* can allow smoke to be introduced into the smoke detection room from the outside and concurrently, prevent light from being introduced into the smoke detection room from the outside.

[0031] Here, as illustrated in FIG. **3**, the base **100***a* may have a plurality of grooves (W**1** to W**4**) for installing the power supply unit **110**, the AC/DC converter **120**, the indoor positioning beacon module **130**, and the fire detection unit **140**.

[0032] The cover **100***b* is formed to cover a bottom surface of the base **100***a*. The cover **100***b* has a mesh formed in an outer wall of the cover **100***b* and preventing small insects from being introduced into the smoke detection room.

[0033] The support **100***c* is installed at the top (i.e., ceiling) within doors and supports the fire detector **100**. The support **100***c* has a slot (G) and, through the slot (G), the base **100***a* is coupled to the support **100***c*.

[0034] Meantime, the power supply unit **110** receives an input of a power source from the external and supplies the power source to the AC/DC converter **120**. The AC/DC converter **120** converts a power source supplied from the power supply unit **110** and supplies a driving power source (for example, a voltage of 5 Volts (V)) to the indoor positioning beacon module **130** and the fire detection unit **140**.

[0035] The indoor positioning beacon module **130** periodically wireless transmits a beacon signal including a beacon IDentifier (ID) to the external through a built-in antenna **131** (referring to FIG. **3**).

[0036] Also, when the fire detection unit **140** detects fire occurrence, the indoor positioning beacon module **130** wireless transmits a beacon signal including a beacon ID to the external through the built-in antenna **131**.

[0037] Here, the indoor positioning beacon module **130** can wireless transmit a beacon signal including a beacon ID through all available wireless communication networks such as a Wireless Fidelity (WiFi) communication network, a Bluetooth communication network, a Zigbee communication network, a Long Term Evolution (LTE) communication network, a 3-Generation (3G) communication network and the like.

[0038] The fire detection unit **140** irradiates light into the smoke detection room (not shown) and receives light scattered by smoke particles within the smoke detection room, thereby detecting fire occurrence or non-occurrence.

[0039] That is, the fire detector **100** of the present invention detects the fire occurrence or non-occurrence, while playing a role of, upon fire occurrence detection or periodically, wireless transmitting the beacon signal including the beacon ID to the external.

[0040] In this exemplary embodiment, a description has been made in which the indoor positioning beacon module **130** is provided in a predetermined position of the base **100***a* but, as illustrated in FIG. **4**, the indoor positioning beacon module **130** may be provided in a Printed Circuit Board (PCB) between the support **100***c* and the base **100***a*.

[0041] FIG. **5** is a diagram illustrating an indoor positioning system according to an exemplary embodiment of the present invention.

[0042] Referring to FIG. **5**, if a fire detector **100** of the present invention wireless transmits a beacon signal including a beacon ID to a portable terminal **500**, the portable terminal **500** carried by a user who is within doors receives the beacon signal from the fire detector **100**, which is located around the portable terminal **500**, through wireless communication.

[0043] Here, the portable terminal **500** refers to a terminal capable of, in a state where an indoor positioning application is executed, transmitting/receiving various data with the fire detector **100** and an indoor positioning server **900** through the wireless communication. The portable terminal **500** can be any one of a tablet Personal Computer (PC) in which wireless communication is possible and application installation is possible, a smart phone, a Personal Digital Assistant (PDA), and a mobile communication terminal. And, the portable terminal **500** can receive beacon signals from one or more fire detectors **100**, respectively, because one or more fire detectors **100** can be located around the portable terminal **500**.

[0044] After receiving the beacon signal, the portable terminal **500** extracts the beacon ID from the received beacon signal, detects a strength of the beacon signal, and stores the extracted beacon ID and the detected signal strength in a memory (not shown). The portable terminal **500** periodically includes the beacon ID and signal strength stored in the memory in a location estimation message and wireless transmits the location estimation message to the external positioning server **900**.

[0045] In an exemplary embodiment, a header of the location estimation message includes identification information (i.e., a Manufacturer's IDentification number (MID)) of the portable terminal **500**, and a body of the location estimation message includes beacon IDs (ID_1, ID_2, ID_3, . . .) acquired from respective beacon signals and strengths (SI_1, SI_2, SI_3, . . .) of the beacon signals.

[0046] If the portable terminal **500** wireless transmits a location estimation message to the external positioning server **900**, the external positioning server **900** receives the location estimation message from the portable terminal **500**, determines a location of a user who carries the portable terminal **500** on the basis of information included in the location estimation message, maps the determined location of the user on a map, and transmits the mapped location of the user to the portable terminal **500**.

[0047] In an exemplary embodiment, the positioning server **900** may transmit the location of the user to external systems (e.g., building management systems, fire rescue systems, public institutions, information provision systems and the like).

[0048] That is, the present invention can detect an accurate current location of a user who carries a portable terminal using the fire detector **100** equipped with the indoor positioning beacon module **130** and accordingly, can simply build an indoor positioning system at a low cost compared to the related art.

[0049] Further, the present invention can detect an accurate current location of a user who carries a portable terminal on the basis of strengths of beacon signals received from fire detectors **100**. Therefore, when a fire or an emergency occurs within a building, the present invention can rapidly detect location information of users and evacuate the users even without going to check if there are persons within doors one by one, making possible rapid lifesaving and initial response against the fire or emergency.

[0050] As described above, exemplary embodiments of the present invention have an effect of being capable of simply building an indoor positioning system at a low cost compared to the related art, by installing a beacon module for indoor positioning in a fire detector to detect an accurate current location of a user who carries a portable terminal.

[0051] Also, exemplary embodiments of the present invention can detect an accurate current location of a user who carries a portable terminal on the basis of strengths of beacon signals received from fire detectors and thus, have an effect of, when a fire or an emergency occurs within a building, being capable of rapidly detecting location information of users who carry portable terminals and evacuate the users even without going to check if there are persons within doors one by one, and making possible rapid lifesaving and initial response against the fire or emergency.

[0052] While the invention has been shown and described with reference to a certain preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A fire detector having a cover formed to cover a bottom surface of a base, and the base coupled to the cover to form a smoke detection room and concurrently form a dark room inside, the fire detector comprising:

a power supply unit for receiving an input of a power source from the external and supplying the power source to an Alternating Current/Direct Current (AC/DC) converter;

the AC/DC converter for converting the power source supplied from the power supply unit and supplying a driving power source to an indoor positioning beacon module;

the indoor positioning beacon module for, upon fire occurrence or periodically, wireless transmitting a beacon signal comprising a beacon IDentifier (ID) to the external through a built-in antenna; and

a fire detection unit for detecting fire occurrence or non-occurrence.

2. The fire detector of claim **1**, wherein the power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit are installed in predetermined positions of the base, and the base has a plurality of grooves for installing the power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit.

3. The fire detector of claim **1**, wherein the indoor positioning beacon module is installed at the top within doors and is

provided in a circuit board between a support supporting a structure of the fire detector and the base.

4. An indoor positioning system comprising:

at least one or more fire detectors each having an indoor positioning beacon module for, upon fire occurrence or periodically, wireless transmitting a beacon signal comprising a beacon IDentifier (ID) to the external through a built-in antenna;

a portable terminal for receiving a beacon signal from the fire detector located around the portable terminal through wireless communication, extracting a beacon ID from the received beacon signal, detecting a strength of the beacon signal, and storing the extracted beacon ID and the detected strength of the beacon signal in a memory, and, upon fire occurrence or periodically, comprising each of the beacon ID and signal strength stored in the memory in a location estimation message and wireless transmitting the location estimation message to the external; and

a positioning server for receiving the location estimation message from the portable terminal through the wireless communication, determining a location of a user who carries the portable terminal on the basis of information comprised in the received location estimation message, mapping the determined location of the user on a map, and wireless transmitting the mapped location to the portable terminal.

5. The indoor positioning system of claim **4**, wherein the fire detector has a cover formed to cover a bottom surface of a base, and the base coupled to the cover to form a smoke detection room and concurrently form a dark room inside,

the positioning system comprising:

a power supply unit for receiving an input of a power source from the external and supplying the power source to an Alternating Current/Direct Current (AC/DC) converter;

the AC/DC converter for converting the power source supplied from the power supply unit and supplying a driving power source to an indoor positioning beacon module;

the indoor positioning beacon module for, upon fire occurrence or periodically, wireless transmitting a beacon signal comprising a beacon IDentifier (ID) to the external through a built-in antenna; and

a fire detection unit for detecting fire occurrence or non-occurrence.

6. The indoor positioning system of claim **5**, wherein, in the fire detector, the power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit are installed in predetermined positions of the base, and the base has a plurality of grooves for installing the power supply unit, the AC/DC converter, the indoor positioning beacon module, and the fire detection unit.

7. The indoor positioning system of claim **5**, wherein, in the fire detector, the indoor positioning beacon module is installed at the top within doors and is provided in a circuit board between a support supporting a structure of the fire detector and the base.

* * * * *