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## OPTICAL TRANSCEIVER, MICROWAVE SENSING APPARATUS COMPRISING SAME, METHOD,SYSTEM, AND STORAGE MEDIUM


### Abstract

The present invention provides a microwave sensing apparatus and a system. The microwave sensing apparatus comprises a sensing module adapted to receive and execute a selected instruction to change a sensing parameter, wherein the sensing parameter is configured to select at least one sub-sensing region; and a communication module adapted to generate the selected instruction in response to at least one trigger signal generated for at least one selected operation of an electronic device in a state of being communicatively connected to the electronic device, wherein the communication module is directly or indirectly electrically connected to the sensing module to send the selected instruction to the sensing module; wherein the sub-sensing region is associated with a target sensing region, so that the target sensing region can be dynamically formed according to different selected operations received by the electronic device.



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## Background/Summary

TECHNICAL FIELD
[0001] The present invention relates to the technical field of sensors, and more particularly to an optical transceiver and a microwave sensing apparatus comprising same, a method, a system, and a storage medium.
BACKGROUND ART
[0002] With the improvement of people's living standards, the demand for intelligent life is increasing. The sensing technology for moving objects in space in IoT technology is an important technology in the development of smart living, especially for the increasing demand for human presence detection. Only by obtaining accurate sensing results can reliable execution basis be provided for terminal devices in smart scenarios.
[0003] In existing related technologies, a microwave sensor emits a sensing beam in a set region, and then obtains a sensing result by detecting an echo fed back by a moving object. However, in the prior art, the sensing range of a microwave sensor is generally configured at the time of delivery. When the microwave sensor is installed at a station to be sensed, its sensing region will be determined accordingly, resulting in a relatively single and fixed sensing region that cannot meet diverse sensing requirements.
SUMMARY OF THE INVENTION
[0004] To overcome the problems in the prior art, the present invention provides an optical transceiver and a microwave sensing apparatus comprising same, a method, a system, and a storage medium.
[0005] According to a first aspect of the present invention, there is provided a microwave sensing apparatus adapted to establish a communication connection with an electronic device having a display interface by a designated network in a state in which the microwave sensing apparatus is communicatively connected to the designated network; the microwave sensing apparatus includes:
[0006] a communication module configured to obtain a selected instruction corresponding to different selected operations performed on at least one representation associated with sensing parameters on the display interface of the electronic device; [0007] a sensing module directly or indirectly communicatively connected to the communication module and adapted to receive and execute the selected instructions sent by the communication module to change sensing parameters; wherein the sensing parameters are used to select at least one sub-sensing region; the sub-sensing region is associated with a target sensing region, enabling the target sensing region to be dynamically formed based on different selected operations received by the electronic device; and the communication module forms sensing results by detecting a moving human body within the target sensing region by the sensing module.
[0008] According to a second aspect of the present invention, there is provided a microwave sensing method applied to a microwave sensing apparatus adapted to establish a communication connection with an electronic device having a display interface by a designated network in a state in which the microwave sensing apparatus is communicatively connected to the designated network; the microwave sensing method includes: [0009] receiving and executing a selected instruction to change a sensing parameter; wherein the selected instruction is generated by the

electronic device based on different selected operations performed on at least one representation associated with the sensing parameter displayed on the display interface thereof; [0010] selecting at least one sub-sensing region based on the sensing parameters; wherein the sub-sensing region is associated with a target sensing region, enabling the target sensing region to be dynamically formed based on different selected operations received by the electronic device; and [0011] forming sensing results by detecting a moving human body within the target sensing region.
[0012] According to a third aspect of the present invention, there is provided a microwave sensing apparatus, including: a sensing module adapted to receive and execute a selected instruction to change a sensing parameter; wherein the sensing parameter is configured to select at least one sub-sensing region; and a communication module adapted to generate the selected instruction in response to at least one trigger signal generated for at least one selected operation of an electronic device in a state of being communicatively connected to the electronic device, wherein the communication module is directly or indirectly electrically connected to the sensing module to send the selected instruction to the sensing module; wherein the sub-sensing region is associated with a target sensing region, so that the target sensing region can be dynamically formed according to different selected operations received by the electronic device, and a moving object in the target sensing region is detected by the sensing module so as to form a sensing result.
[0013] According to a fourth aspect of the present invention, there is provided a microwave sensing method applied to a microwave sensing apparatus, the microwave sensing method including: [0014] changing sensing parameters in response to at least one trigger signal produced by at least one selected operation performed on the electronic device when communicatively connected to the electronic device; wherein the sensing parameters are used to select at least one sub-sensing region; the sub-sensing region is associated with a target sensing region, enabling the target sensing region to be flexibly divided based on different selected operations received by the electronic device; and [0015] forming sensing results by detecting a moving object within the target sensing region.
[0016] According to a fifth aspect of the present invention, there is provided an optical transceiver suitable applied to the microwave sensing apparatus according to the first aspect and its alternatives, or the microwave sensing apparatus according to the third aspect and its alternatives, the optical transceiver including: [0017] a light-transmitting part configured to allow light to pass through, enabling light emitted by the microwave sensing apparatus in a first direction to pass from inside the microwave sensing apparatus to outside through the light-transmitting part, and light incident from outside the microwave sensing apparatus in a second direction to enter inside the microwave sensing apparatus through the light-transmitting part; and [0018] a trigger part provided on the light-transmitting part and configured to trigger the microwave sensing apparatus in response to a first operating force.
[0019] According to a sixth aspect of the present invention, there is provided a microwave sensing apparatus including a memory and a processor; [0020] the memory is configured to store code; and [0021] the processor is configured to execute the code in the memory to implement the method according to the second aspect and its alternatives.
[0022] According to a seventh aspect of the present invention, there is provided a microwave sensing apparatus including a memory and a processor; [0023] the memory is configured to store code; and [0024] the processor is configured to execute the code in the memory to implement the method according to the fourth aspect and its alternatives.
[0025] According to an eighth aspect of the present invention, there is provided a control system based on a microwave sensing apparatus, including the microwave sensing apparatus according to the first aspect and its alternatives. According to a ninth aspect of the present invention, there is provided a control system based on a microwave sensing apparatus, including the microwave sensing apparatus according to the third aspect and its alternatives. According to a tenth aspect of the present invention, there is provided a storage medium having stored thereon a program which, when executed by a processor, implements the microwave sensing method according to the second

aspect and its alternatives.
[0026] According to an eleventh aspect of the present invention, there is provided a storage medium having stored thereon a program, wherein the program, when executed by a processor, implements the microwave sensing method according to the fourth aspect and its alternatives.
[0027] Based on the optical transceiver and the microwave sensing apparatus, method, system, and storage medium comprising same as provided in the first to eleventh aspects above, the beneficial effects of the technical solutions provided by the embodiments of the present invention at least include the followings. The communication module establishes a communication connection with an electronic device and adjusts the sensing parameters of the sensing module based on selected operations received by the electronic device to adjust the target sensing region of the microwave sensing apparatus, thereby flexibly adjusting the target sensing region of the microwave sensing apparatus based on the electronic device, enabling the target sensing region to be flexibly changed according to different sensing range requirements, and improving the applicability of the microwave sensing apparatus.
[0028] It should be understood that the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the present invention.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0029] To more clearly illustrate the technical solutions in the embodiments of the present invention or the prior art, the accompanying drawings required for describing the embodiments or the prior art will be briefly introduced below. The accompanying drawings incorporated in and constituting a part of this description illustrate embodiments consistent with the present application and, together with the description, serve to explain the principles of the present application. Obviously, the drawings in the following description are merely some embodiments of the present invention. For those of ordinary skill in the art, other drawings can be obtained based on these drawings without creative effort.
[0030] FIG. **1** is a schematic circuit structure diagram of a microwave sensing apparatus according to an embodiment of the present invention;
[0031] FIG. **2** is a schematic diagram of a communication connection between a communication module and an electronic device according to an embodiment of the present invention;
[0032] FIG. **3** is a schematic diagram illustrating an electronic device displaying a representation of maximum sensing distance adjustment on the display interface thereof according to an embodiment of the present invention;
[0033] FIG. **4** is a schematic diagram illustrating an electronic device displaying a representation of minimum sensing distance adjustment on the display interface thereof according to an embodiment of the present invention;
[0034] FIG. **5** is a schematic diagram illustrating an electronic device displaying representations of maximum and minimum sensing distance adjustments on the display interface thereof according to an embodiment of the present invention.
[0035] FIG. **6** is a schematic diagram illustrating an electronic device displaying a representation of target sensing region segment division adjustment on the display interface thereof according to an embodiment of the present invention;
[0036] FIG. **7** is a first schematic diagram of an interface after selection based on FIG. **6**;
[0037] FIG. **8** is a schematic diagram of a target sensing region formed by sub-sensing regions corresponding to the selected segment range of FIG. **7** according to an embodiment of the present invention;
[0038] FIG. **9** is a second schematic diagram of an interface after selection based on FIG. **6**

according to an embodiment of the present invention;
[0039] FIG. **10** is a further connection schematic diagram of the communication connection between the communication module and the electronic device based on FIG. **2**;
[0040] FIG. **11** is a schematic diagram illustrating the first result displayed on the display interface of the electronic device according to an embodiment of the present invention;
[0041] FIG. **12** is a schematic diagram illustrating a representation of the second result formed on the display interface of the electronic device according to an embodiment of the present invention;
[0042] FIG. **13** is a further first schematic diagram of the circuit structure based on the microwave sensing apparatus of FIG. **1**;
[0043] FIG. **14** is a schematic diagram illustrating the third result displayed on the display interface of the electronic device according to an embodiment of the present invention;
[0044] FIG. **15** is a further second schematic diagram of the circuit structure based on the microwave sensing apparatus of FIG. **1**;
[0045] FIG. **16** is a further third schematic diagram of the circuit structure based on the microwave sensing apparatus of FIG. **1**;
[0046] FIG. **17** is a schematic diagram illustrating the representation of illumination intensity formed on the display interface of the electronic device according to an embodiment of the present invention.
[0047] FIG. **18** is a schematic diagram of another communication connection between the communication module and the electronic device according to the present invention;
[0048] FIG. **19** is a schematic circuit structure diagram of a microwave sensing apparatus according to another embodiment of the present invention;
[0049] FIG. **20** is a schematic circuit structure diagram of a microwave sensing apparatus including a power management module according to an embodiment of the present invention;
[0050] FIG. **21** is a specific implementation circuit diagram of FIG. **20**;
[0051] FIG. **22** is an exploded structural diagram of an embodiment of the microwave sensing apparatus provided by the present invention;
[0052] FIG. **23** is a structurally schematic diagram of the microwave sensing apparatus of FIG. **22**;
[0053] FIG. **24** is a structurally schematic diagram of the housing and the optical transceiver (fully assembled) from another perspective of FIG. **22**;
[0054] FIG. **25** is a structurally schematic diagram of the housing, communication module, and PCB board (fully assembled) from another perspective of FIG. **22**;
[0055] FIG. **26** is a structurally schematic diagram of the sensing module of FIG. **22**;
[0056] FIG. **27** is a structurally schematic diagram of the first movable member of FIG. **22**;
[0057] FIG. **28** is a structurally schematic diagram of the second movable member of FIG. **22**;
[0058] FIG. **29** is a structurally schematic diagram of the first movable member and the base (fully assembled) from another perspective of FIG. **22**;
[0059] FIG. **30** is a schematic diagram of the microwave sensing apparatus of FIG. **22** in a first state (the angle between the first contact surface and the second contact surface is 0 degree);
[0060] FIG. **31** is a schematic diagram of the microwave sensing apparatus in FIG. **22** in a second state (the included angle between the first contact surface and the second contact surface is 90 degrees);
[0061] FIG. **32** is a schematic diagram of the microwave sensing apparatus in FIG. **22** in a second state (the included angle between the first contact surface and the second contact surface is 180 degrees);
[0062] FIG. **33** is a structurally exploded schematic diagram of another embodiment of the microwave sensing apparatus according to the present invention;
[0063] FIG. **34** is a structurally schematic diagram of the microwave sensing apparatus in FIG. **33**;
[0064] FIG. **35** is a structurally exploded schematic diagram of yet another embodiment of the microwave sensing apparatus according to the present invention;

[0065] FIG. **36** is a structurally schematic diagram of the microwave sensing apparatus of FIG. **35**;
[0066] FIG. **37** is a structurally schematic diagram of a portion of the microwave sensing apparatus in FIG. **35**;
[0067] FIG. **38** is a structurally schematic diagram of the housing in FIG. **35** from another perspective;
[0068] FIG. **39** is a structurally schematic diagram of the microwave sensing apparatus in FIG. **35** in a mounted state (the included angle between the housing and the mounting bracket is 0 degree);
[0069] FIG. **40** is a structurally schematic diagram of the microwave sensing apparatus in FIG. **35** in another mounted state (the included angle between the housing and the mounting bracket is 30 degrees);
[0070] FIG. **41** is a structurally exploded schematic diagram of yet another embodiment of the microwave sensing apparatus according to the present invention;
[0071] FIG. **42** is a structurally schematic diagram of the housing and mounting bracket in FIG. **41** in the mounted state;
[0072] FIG. **43** is a structurally schematic diagram of the microwave sensing apparatus in FIG. **41** from another perspective;
[0073] FIG. **44** is a structurally exploded schematic diagram of yet another embodiment of the microwave sensing apparatus according to the present invention;
[0074] FIG. **45** is a structurally schematic diagram of an embodiment of the optical transceiver according to the present invention from one perspective;
[0075] FIG. **46** is a structurally schematic diagram of the optical transceiver in FIG. **44** from another perspective;
[0076] FIG. **47** is a schematic flow chart of a microwave sensing method according to an embodiment of the present invention;
[0077] FIG. **48** is a first schematic diagram showing a first result displayed on the display interface of the electronic device according to an embodiment of the present invention;
[0078] FIG. **49** is a first schematic diagram showing a second result displayed on the display interface of the electronic device according to an embodiment of the present invention;
[0079] FIG. **50** is a first schematic diagram showing a third result displayed on the display interface of the electronic device according to an embodiment of the present invention;
[0080] FIG. **51** is a schematic flow chart of a microwave sensing method according to another embodiment of the present invention;
[0081] FIG. **52** is a structurally schematic diagram of a microwave sensing apparatus according to another embodiment of the present invention; and
[0082] FIG. **53** is a structurally schematic diagram of a control system according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0083] The embodiments of the present invention will be described in detail below. When the following description refers to the accompanying drawings, unless otherwise indicated, the same numerals in different drawings represent the same or similar elements. Obviously, the described embodiments are only some embodiments of the present invention, not all of them. Based on the embodiments of the present invention, all other embodiments obtained by those of ordinary skill in the art without creative efforts shall fall within the protection scope of the present invention.
[0084] It should be understood that in the description of all embodiments of the present invention, the orientation or positional relationship indicated by terms such as “upper”, “lower”, “left”, and “right” is based on the orientation or positional relationship shown in the drawings, and is only for the convenience of describing the present invention and simplifying the description, rather than indicating or implying that the referred device or element must have a specific orientation, be constructed and operated in a specific orientation, and thus should not be construed as limiting the present invention. The terms “first” and “second” are used for descriptive purposes only and cannot

be understood as indicating or implying relative importance or implicitly indicating the number of technical features. Thus, features defined by “first” and “second” may explicitly or implicitly include one or more such features. Terms such as “coupling” and “connection” should be understood broadly, for example, they may be fixed connections, detachable connections, or integrated connections; they may be mechanical connections, electrical connections, or communication connections; they may be direct connections, or indirect connections through an intermediate medium to form a linkage relationship, or they may be internal connections between two elements or interaction relationships between two elements. For those of ordinary skill in the art, the specific meanings of the above terms in the present invention can be understood according to specific circumstances.

[0085] The microwave sensing apparatus obtains a sensing result indicating the presence or absence of a moving object by actively emitting detection waves outwards and detecting based on the echo fed back by the moving object. However, the inventors of the present invention have found that if a user has sensing range requirements for multiple application scenarios simultaneously (for example, the sensing range at a doorway is required to be smaller, while the sensing range in a living room is required to be larger), or the same application scenario requires different sensing ranges under different circumstances (for example, a living room equipped with a floor-sweeping robot is required to have a smaller sensing range when the robot is working to avoid sensing the robot on the ground, and a larger sensing range when the robot is not working to achieve a full coverage), a microwave sensing apparatus with a single sensing range cannot meet the requirements of multiple sensing ranges, and the users need to configure multiple microwave sensing apparatuses matching the corresponding application scenarios, which will undoubtedly affect the user experience of the product. Based on this, the inventors provide a microwave sensing apparatus, a method, a system, and a storage medium to solve the problem that existing microwave sensing apparatuses have single and fixed sensing regions and cannot meet diverse sensing requirements.

[0086] Referring to FIG. **1**, a microwave sensing apparatus **100** proposed by the present invention is specifically illustrated. As shown in FIG. **1**, a schematic circuit structure diagram of the microwave sensing apparatus **100** according to an embodiment of the present invention is shown. It can be seen that the microwave sensing apparatus **100** at least includes a sensing module **31**, adapted to receive and execute a selected instruction to change sensing parameters; wherein the sensing parameters are used to select at least one sub-sensing region; a communication module **5** adapted to generate the selected instruction in response to at least one trigger signal generated for at least one selected operation of an electronic device **200** in a state of being communicatively connected to the electronic device **200**, wherein the communication module **5** is directly or indirectly electrically connected to the sensing module **31** to send the selected instruction to the sensing module **31**; wherein the sub-sensing region is associated with a target sensing region, so that the target sensing region can be dynamically formed according to different selected operations received by the electronic device **200**, and a moving object in the target sensing region is detected by the sensing module **31** so as to form a sensing result.

[0087] Here, the trigger signal should be understood as any electrical signal that can trigger the communication module **5** to generate the selected instruction, such as a wirelessly transmitted control message or a wired level signal. The selected operation should be understood as a physical operation or a virtual operation, which can be a single operation or a series of related operations. Therefore, the trigger signal can be generated by a single selected operation or jointly output by multiple related selected operations. It should be noted that regardless of the form of the selected operation and the trigger signal, it does not affect the implementation of this embodiment and thus should not be used to limit the protection scope of the present invention.

[0088] Based on the above technical solution, it can be seen that in the embodiment of the present invention, the communication module **5** establishes a communication connection with an electronic device **200** and adjusts the sensing parameters of the sensing module **31** based on the selected operation received by the electronic device **200** to adjust the target sensing region of the microwave sensing apparatus **100**, thereby flexibly adjusting the target sensing region of the microwave sensing apparatus **100** based on the electronic device **200**, enabling the target sensing region to be flexibly changed based on different sensing range requirements, and improving the applicability of the microwave sensing apparatus **100**.

[0089] It should be further noted that the sub-sensing region is a sensing region defined by the sensing parameters within the actual sensing region of the sensing module **31**, and the actual sensing region is the actual region effectively covered by the detection waves (such as radar electromagnetic waves) of the sensing module **31**. In one method of forming the sub-sensing regions, the sensing module **31** divides its detectable actual sensing region into multiple sequentially connected sub-sensing regions and forms sensing parameters characterizing each sub-sensing region, so that the communication module **5** can select different sub-sensing regions by configuring the sensing module **31** with different sensing parameters. The sensing parameters may specifically characterize the position values (such as boundary values, i.e., maximum sensing distance values and/or minimum sensing distance values) of each sub-sensing region.

[0090] In one example, the sensing parameters include a maximum sensing distance value to define the maximum sensing distance of a sub-sensing region. The sensing module **31** is further configured to change the maximum sensing distance value based on a selected instruction, so that the maximum sensing distance of a target sensing region including the sub-sensing region can be flexibly set. In this example, the communication module **5** can control the sensing module **31** to adjust the maximum sensing distance in the sensing parameters based on the selected operation of the electronic device **200**, so that the maximum sensing distance of the target sensing region of the microwave sensing apparatus **100** can be flexibly set, facilitating the modification of the coverage of the target sensing region starting from the microwave sensing apparatus by changing the maximum sensing distance, thereby adapting to different sensing distance requirements.

[0091] In another example, the sensing parameters include a minimum sensing distance value to define the minimum sensing distance of a sub-sensing region. The sensing module **31** is further configured to change the minimum sensing distance value based on a selected instruction, so that the minimum sensing distance of a target sensing region including the sub-sensing region can be flexibly set. In this example, the communication module **5** can control the sensing module **31** to adjust the minimum sensing distance in the sensing parameters based on the selected operation of the electronic device **200**, so that the minimum sensing distance of the target sensing region of the microwave sensing apparatus **100** can be flexibly set.

[0092] In yet another example, the sensing parameters include at least one segment range starting from a first distance value and ending at a second distance value, for instructing the sensing module **31** to divide a sub-sensing region having the first distance value as a minimum sensing distance boundary value and the second distance value as a maximum sensing distance boundary value; where the first distance value is less than the second distance value and greater than zero; the communication module **5** is further configured to enable the sensing module **31** to vary the first distance value and/or the second distance value based on a selected instruction, thereby changing the minimum sensing distance and/or maximum sensing distance of a target sensing region including the sub-sensing region. In this example, the communication module **5** can control the sensing module **31** to adjust the starting point and/or ending point of the segment range in the sensing parameters based on the selected operation of the electronic device **200**, so that the minimum sensing distance and/or maximum sensing distance of the target sensing region of the microwave sensing apparatus **100** can be flexibly set. For example, in some use scenarios, the mounting position of the microwave sensing apparatus **100** is not the region to be sensed, and the region to be sensed is not convenient for mounting the microwave sensing apparatus **100**. In this case, it is desirable to set the region adjacent to the mounting position of the microwave sensing apparatus **100** as a non-sensing region, while the actual sensing region of the microwave sensing apparatus **100** can cover the region to be sensed. Then, in the actual sensing region of the microwave sensing apparatus **100**, the sub-sensing region corresponding to the region to be sensed is selected as the target sensing region. At this time, it is necessary to exclude the region adjacent to the mounting position of the microwave sensing apparatus **100** by setting the minimum sensing distance, thereby forming the target sensing region capable of covering the region to be sensed by defining a sub-sensing region by the minimum sensing distance and the maximum sensing distance.

[0093] In a further example based on the above example, the sensing parameters include a plurality of sets of designated segment ranges, wherein each of the segment ranges is configured to instruct the sensing module **31** to divide a sub-sensing region having a minimum sensing distance value at a starting point of the segment range and a maximum sensing distance value at an ending point of the segment range; the communication module **5** is further configured to enable the sensing module **31** to select, based on a selected instruction, one or more sets of sub-sensing regions corresponding to the segment range to which the selected instruction is directed, so that the target sensing region can be precisely set according to the different sub-sensing regions selected.

[0094] It can be understood that, based on the technical solution provided in the above embodiment, users can form a plurality of sub-sensing regions with their respective segment ranges (for example, dividing the entire region of [0 m, 6 m] into three sub-sensing regions corresponding to segment ranges of [0 m, 2 m], [2 m, 4 m], and [4 m, 6 m]) by segmenting an entire region (which can be the actual sensing region or a region divided from the actual sensing region). This allows users to select the sub-sensing regions corresponding to the segment ranges based on the position of the region to be sensed, thereby forming a precise target sensing region. Defining each sub-sensing region by the segment range only requires setting the minimum and maximum distance boundaries of each sub-sensing region. Compared to dividing sub-sensing regions using coordinate values, angle values, etc., the boundary values of each sub-sensing region in the solution provided in this embodiment can be easily divided based on the distance values detected by the sensing module **31**. The division of each sub-sensing region in this embodiment can be achieved by the sensing module **31** with the basic distance detection function, without requiring a powerful sensing module **31** (e.g., with the angle detection function), thereby reducing the overall manufacturing cost of the microwave sensing apparatus **100**. In addition, for a sensing module, the distance detection is easier and more accurate than detecting angles or coordinates. Therefore, the division of each sub-region based on different distance values in this embodiment is more accurate than other methods such as coordinate values or angle values.

[0095] Furthermore, the inventors of the present invention have found that in daily use scenarios, the region to be sensed is often not a continuous range but may consist of a plurality of discrete ranges. If a large sensing region is used to cover the plurality of discrete regions to be sensed, the non-sensing regions between two adjacent regions to be sensed will also be detected, making it impossible to accurately cover the regions to be sensed. This also increases the overall power consumption of the product due to unnecessary coverage of non-detection regions. Based on this, a specific implementation of the above example provides a related solution to this technical problem. Specifically, in this embodiment, the plurality of sets of designated segment ranges can be combined to form a complete range, and the plurality of sets of segment ranges are non-completely overlapping. Thus, the sensing module **31** can select a plurality of non-overlapping segment ranges according to a selected instruction, allowing the target sensing region to be combined in a discontinuous manner by a plurality of discontinuous sub-sensing regions. Therefore, based on the technical solution provided in this embodiment, a discontinuous target sensing region can be formed by the users by discontinuous selection of different sub-sensing regions corresponding to a plurality of discontinuous regions to be sensed, thereby improving the accuracy of the target sensing region's coverage of each region to be sensed. For example, in some application scenarios such as an office setting, the regions where workstations are located are the regions to be sensed. After detecting moving objects at each workstation, some electrical devices (e.g., turning on lights) can be activated. The corridors between workstations are non-sensing regions. If an existing microwave sensing apparatus with only overall region sensing function is used to cover multiple workstations, the corridor regions between adjacent workstations will inevitably be covered, resulting in inaccurate coverage of the regions to be sensed. However, based on the technical solution disclosed in this embodiment, the target sensing region can be formed by discontinuous selection of the segment ranges corresponding to the sub-sensing regions where each workstation is located, thereby excluding non-sensing regions such as corridors and achieving precise coverage of each workstation region by the target sensing region.

[0096] Referring to FIG. **2**, a specific example of a communication connection between the communication module **5** and the electronic device **200** is illustrated. In the embodiment shown in FIG. **2**, the communication module **5** is adapted to establish a communication connection with an electronic device **200** having a display interface by a designated network in a state of being communicatively connected to the designated network, thereby acquiring a selected instruction corresponding to the selected operation according to at least one different selected operation associated with a representation of the sensing parameter with respect to a display interface of the electronic device **200**. It should be noted that the term "representation" in this embodiment and the following refers to any user-interactive graphical display interface object optionally displayed on the display interface of the electronic device **200**. For example, images (e.g., curves, icons), sliders, and text (e.g., words, hyperlinks) in FIGS. **3-7**, **9**, **11**, **12**, and **14** of the drawings optionally each constitute corresponding representations. The designated network can be a local area network established based on a gateway device. The communication module **5** can access the designated network via a gateway and/or router using one or more wireless methods such as Zigbee, WiFi, or BLE Mesh, or via wired methods such as PLC (Power Line Communication). In one example, the communication module **5** is connected to a local area network constructed by a Bluetooth gateway via the BLE Mesh protocol. All electronic devices **200** accessing this local area network are stored in the device list of the Bluetooth gateway. The communication module **5** can establish a communication interaction relationship with an electronic device **200** connected to this local area network by the Bluetooth gateway. The electronic device **200** can be, for example, a smart device with a display interface and human-computer interaction functions, such as a mobile phone, a tablet computer, a smartwatch, or smart glasses. In a specific example where the electronic device **200** is a mobile phone, the mobile phone runs an application program corresponding to the microwave sensing apparatus. The mobile phone binds the microwave sensing apparatus under the account of the application program via Bluetooth or WiFi, enabling operation of the microwave sensing apparatus by the app. Additionally, the mobile phone can instruct the communication module of the microwave sensing apparatus to join a designated network. After joining the network, the microwave sensing apparatus can receive trigger signals sent by the mobile phone. The mobile phone sends corresponding trigger signals to the communication module of the microwave sensing apparatus based on selected operations on the app interface displayed on the display interface thereof.

[0097] Thus, based on the technical solution provided in this embodiment, the electronic device **200** has a display interface. Users can connect the electronic device **200** (e.g., a smartphone) and the microwave sensing apparatus **100** to the same designated network, and then conveniently set the target sensing region of the microwave sensing apparatus **100** by the display interface on the electronic device **200**. The visual selected operation method is user-friendly, allowing the users to make more accurate divisions of the target sensing region for specific application scenarios.

[0098] As shown in FIG. **3**, a specific application example of the above embodiment is illustrated. FIG. **3** shows a display interface of an electronic device **200** connected to the communication module **5**, with a representation for adjusting the maximum sensing distance. The electronic device

**200** can generate a corresponding trigger signal based on the user's selected operation on the representation of the maximum sensing distance, and then send the trigger signal to the communication module **5** via the designated network to trigger the communication module **5** to generate a selected instruction for controlling the sensing module **31** to adjust the maximum sensing distance. As shown in FIG. **4**, another specific application example of the above embodiment is illustrated. FIG. **4** shows a display interface of an electronic device **200** connected to the communication module **5**, with a representation for adjusting the minimum sensing distance. The electronic device **200** can generate a corresponding trigger signal based on the user's selected operation on the representation of the minimum sensing distance, and then send the trigger signal to the communication module **5** via the designated network to trigger the communication module **5** to generate a selected instruction for controlling the sensing module **31** to adjust the minimum sensing distance.

[0099] As shown in FIG. **5**, yet another specific application example of the above embodiment is illustrated. FIG. **5** shows a display interface of an electronic device **200** connected to the communication module **5**, with representations for adjusting both the minimum and maximum sensing distances. The electronic device **200** can generate a corresponding trigger signal based on the user's selected operation on the representations of the minimum and/or maximum sensing distances, and then send the trigger signal to the communication module **5** via the designated network to trigger the communication module **5** to generate a selected instruction for controlling the sensing module **31** to adjust the minimum and/or maximum sensing distances.

[0100] As shown in FIG. **6**, a further specific application example of the above embodiment is illustrated. FIG. **6** shows a display interface of an electronic device **200** communicatively connected to the communication module **5** of the microwave sensing apparatus **100**, with representations of eight groups of designated segment ranges: [0, 0.8], [0.8, 1.5], [1.5, 2.3], [2.3, 3.0], [3.0, 3.8], [3.8, 4.5], [4.5, 5.3], [5.3, 6.0]. Each segment range is used to instruct the sensing module **31** to divide a sub-sensing region with the starting point of the segment range as the minimum sensing distance value and the ending point as the maximum sensing distance value. For example, the sub-sensing region divided by the segment range [1.5, 2.3] has a minimum sensing distance value of 1.5 m and a maximum sensing distance value of 2.3 m. Other segment ranges can be understood similarly. The electronic device **200** generates a trigger signal based on the user's selected operation on the representation of at least one of the eight groups of segment ranges on the display interface thereof. The trigger signal is used to trigger the communication module **5** to generate a corresponding selected instruction, thereby configuring the target sensing region of the sensing module **31** to match the sensing regions corresponding to the selected segment ranges based on the selected instruction. For example, as shown in FIG. **7**, when segment ranges [0.8, 1.5], [1.5, 2.3], and [2.3, 3.0] are selected on the basis of FIG. **6**, a precise target sensing region can be formed correspondingly as shown in FIG. **8**. It should be noted that the target sensing region shown in FIG. **8** is a schematic region for ease of understanding and does not represent the actual sensing region of the microwave sensing apparatus.

[0101] Further, the display interface of the electronic device **200** as shown in FIG. **7** has eight groups of specified segment ranges which in turn combine to form a complete range [0, 6] which characterizes a complete region with 0 m as the minimum sensing boundary and 6 m as the maximum sensing boundary, which is included in the actual sensing region of the sensing module **31**. Furthermore, since the sub-sensing regions corresponding to the sensing ranges of each group do not completely coincide, the user can set a discontinuous target sensing region based on the discontinuous selected operation for the segment ranges of the plurality of groups. For example, FIG. **9** shows four segment ranges [0.8, 1.5], [2.3, 3.0], [3.0, 3.8] and [5.3, 6.0] selected on the basis of FIG. **6**, where the segment ranges [0.8, 1.5] and [2.3, 3.0] are skipped, and the segment ranges [3.0, 3.8] and [5.3, 6.0] are also skipped, so that three sub-sensing regions with sensing ranges of 0.8 m-1.5 m, 2.3 m-3.8 m and 5.3 m-6.0 m can be formed, respectively. In turn, the three sub-sensing regions combine together to form a discontinuous target sensing region. It should be understood that the segment skipping arrangement as shown in FIG. **9** is an illustrative example. In practical use, a user can freely select various segment ranges based on specific application requirements so as to form various combinations of sub-sensing regions, thereby forming a target sensing region for satisfying various sensing requirements.

[0102] Based on the above description, it can be understood that, based on the technical solution provided by this embodiment, a user can precisely select a desired target sensing region based on a selected operation for a series of segment ranges visually displayed on the electronic device **200**, so that the target sensing region of the microwave sensing apparatus **100** can be precisely defined based on a user's setting.

[0103] As shown in FIG. **10**, in some embodiments, the communication module **5** is further adapted to, in a state of being communicatively connected to a designated network, be communicatively connected to a cloud server **300** by the designated network, so as to be able to generate a corresponding selected instruction according to a control message issued by the cloud server **300**; and the control messages are generated and uploaded by the electronic device **200** based on different selected operations for which the display interface has at least one representation associated with the sensing parameter. Furthermore, according to this embodiment, the electronic device **200** can remotely set a target sensing region of the microwave sensing apparatus **100** by the cloud server **300**.

[0104] Furthermore, it should be noted that the sensing result should be understood as one or more of a plurality of sensing results, i.e., the communication module **5** can output one or more of a plurality of sensing results at a time based on the processing of the detection result by the sensing module **31**. Furthermore, one or more of a plurality of sensing results may also be in the sensing results sent out, and the plurality of sensing results may be sent out via one control message, or may be sent out via multiple control messages respectively. With regard to various sensing results, the embodiment described later provides a specific technical solution of some of the sensing results.

[0105] In some embodiments of the present invention, the communication module **5** is further configured to send a first result out, in a case that the sensing result within a specified time is the first result of a plurality of sensing results, to enable the electronic device **200** to form a representation characterizing the first result on the display interface thereof in response to the first result; the specified time is set by the electronic device **200** according to a setting operation received by the display interface thereof; and the first result characterizes that no moving object is detected within the target sensing region. As shown in FIG. **11**, it shows a representation of the first result being formed on a display interface of the electronic device **200**. In one specific example, when the microwave sensing apparatus **100** is used to detect the presence of a person in an environment, the display interface of the electronic device **200** will display “No person” when the sensing result is the first result, for easy viewing by a user. Further, in the present embodiment, the communication module **5** will not upload it immediately when detecting that the sensing result is the first result, but will not upload it until a specified time is delayed and the first result is continuously detected for a specified time, so as to reduce the amount of data to be uploaded. It should be understood that the first result is indicative of “no person”. In some application scenarios, the no-person time will be much greater than the person time. Thus, if the “no person” sensing result is reported frequently, the data uploading pressure of the microwave sensing apparatus **100** will be high, and the electronic device **200** will also receive data too frequently, so that the delayed reporting (or conditional reporting) of the “no person” sensing result provided in the present embodiment can effectively solve this problem.

[0106] Further, in an embodiment, the communication module **5** is further configured and adapted to calculate a duration time of a first result to form a fourth result sent out when the sensing result is a first result of the plurality of sensing results, such that the electronic device **200** can form a representation characterizing the fourth result on the display interface thereof in response to the fourth result. As shown in FIG. **11**, the display interface of the electronic device **200** shows a representation of the fourth result formed on the display interface of the electronic device **200**. When the sensing result is the first result, the display interface of the electronic device **200** displays the first result for a duration time to form a representation of the fourth result that is convenient for a user to view. Furthermore, in some embodiments, when the fourth result accumulates to a certain length of time, the update will be stopped. For example, when the current fourth result is “no person, duration time of 4 hours”, the update of the representation of the fourth result on the display interface is stopped, so as to prevent unnecessary data reporting caused by a long-time non-triggering state in the region to be detected.

[0107] In addition, in this embodiment, the communication module **5** is further configured to execute a command from an application to change the specified time. The application may be an application program (app) running on an intelligent terminal (such as the electronic device **200**). In other words, a user can adjust the specified time by any intelligent terminal running a related application and establishing a communication connection with the communication module **5**, so as to change the delayed reporting time of the first result, making the update rule of the first result on the display interface of the electronic device **200** applicable to specific application scenarios. In some embodiments of the present invention, the communication module **5** is further configured to immediately send a second result out when the sensing result is a second result of a plurality of sensing results, to enable the electronic device **200** to form a representation characterizing the second result on the display interface thereof in response to the second result. The second result characterizes that the moving object is detected within the target sensing region. FIG. **12** shows a representation of the second result being formed on the display interface of the electronic device **200**. In one specific example, when the microwave sensing apparatus **100** is configured to detect the presence of a person in an environment, and the sensing result is the second result, the display interface of the electronic device **200** will display “Occupied” for easy viewing by the user. Furthermore, in the present embodiment, the communication module **5** will upload the sensing result immediately when detecting that the sensing result is the second result, so as to facilitate the user to immediately master the triggering result of the moving object in the target sensing region, or upload the sensing result immediately when the sensing result is linked with other devices, so as to enable the linked devices to respond quickly and reduce the delay.

[0108] In a particular embodiment, the communication module **5** is further configured and adapted to calculate a duration time of a second result to form a sixth result to be sent out when the sensing result is a second result of the plurality of sensing results, such that the electronic device **200** can form, in response to the sixth result, a representation characterizing the sixth result via the display interface thereof. As shown in FIG. **12**, a representation of the sixth result being formed on a display interface of the electronic device **200**. When the sensing result is a second result, the display interface of the electronic device **200** displays the second result for a duration time to form a representation of the sixth result which is convenient for a user to view. Furthermore, in some embodiments, when the sixth result accumulates to a certain length of time, the update will be stopped. For example, when the current sixth result is “occupied, duration time of 4 hours”, the update of the representation of the sixth result on the display interface is stopped, so as to prevent unnecessary data reporting caused by the triggering state for a long time in the region to be detected.

[0109] Further, referring to FIG. **13**, in some embodiments, in order to visually display the triggering state of the second result, the microwave sensing apparatus **100** further includes a light-emitting module **33** electrically connected to the communication module **5**. The communication module **5** is further configured to control the light-emitting module **33** to emit an indication signal of a specified rule when the sensing result is the second result, thereby visually informing the user that the second result is triggered by the indication signal of the specified rule. In one example, the indication signal of the specified rule includes a light signal of a specified color flashed at a frequency of a certain period (for example, a blue light is flashed at an interval of 5 s), and a user can know that the second result is triggered when he or she sees that the flashing light signal is emitted from the microwave sensing apparatus **100**.

[0110] In some embodiments of the present invention, the sensing module **31** is further configured to detect a position parameter of a moving object within the target sensing region, and the communication module **5** obtains the position parameter and performs corresponding processing to form a third result of a plurality of sensing results. Further, based on this embodiment, the communication module **5** can acquire the distance value of the moving object within the target sensing region.

[0111] Further, in some embodiments, the communication module **5** is further configured to be adapted to periodically send a third result of the plurality of sensing results out when the sensing result is the second result, to enable the electronic device **200** to form a representation characterizing the third result on the display interface thereof in response to the third result. The third result characterizes the distance between the moving object within the target sensing region and the sensing module **31**. FIG. **14** shows a representation of the third result being formed on the display interface of the electronic device **200**. In one specific example, when the microwave sensing apparatus **100** is used to detect the presence of a person in an environment, and the sensing result is the second result, the display interface of the electronic device **200** will display a "distance value" for easy viewing by the user.

[0112] Further, in some embodiments, the communication module **5** is further configured to determine a movement direction of a moving object within a target sensing region based on a trend of change of the third result over a specified period of time. The movement direction includes both moving away and closer. In a specific example, the communication module **5** determines the movement direction of the moving object by analyzing the distance value (third result) of the moving object within 1 second, and determines that the moving object approaches in the direction towards the microwave sensing apparatus **100** if the distance value obtained within 1 second is gradually decreased, and otherwise determines that the moving object is moved away from the microwave sensing apparatus **100**.

[0113] Further, in some embodiments, the communication module **5** is also configured to set a specified boundary, and can determine whether the moving object crosses the specified boundary according to the third result. For example, if the specified boundary is a boundary with a distance value of 5 meters, the third result determines that the moving object has crossed the specified boundary if the distance value characterized in the specified period covers the 5-meter boundary. Furthermore, based on the determination of whether the moving object crosses the specified boundary and the determination of the movement direction of the moving object, the communication module **5** can form a fifth result of a plurality of sensing results, the fifth result characterizing that the moving object within the target sensing region crosses the specified boundary in a manner of moving closer and away within the target sensing region. Specifically, the communication module **5** is further configured to send out the fifth result when the sensing result is the fifth result of a plurality of sensing results, so that the electronic device **200** can form a representation characterizing the fifth result on the display interface thereof in response to the fifth result. In a specific example, when the microwave sensing apparatus **100** is used to detect the presence of a person in an environment, and the sensing result is the fifth result, the "someone approaching" displayed on the display interface of the electronic device **200** indicates that the moving object crosses the specified boundary in an approaching manner within the target sensing region. The "someone departing" displayed on the display interface of the electronic device **200** indicates that the moving object crosses the specified boundary in a departing manner within the target sensing region, facilitating user viewing and performing various intelligent linkages based on the fifth result.

[0114] In addition, to maximize the accuracy of the fifth result and eliminate interference, an embodiment of the present invention provides a corresponding technical solution. In this embodiment, a left boundary and a right boundary of a preset interval are set based on the specified boundary, where the left boundary equals the specified boundary minus the preset interval, and the right boundary equals the specified boundary plus the preset interval. Thus, “someone approaching” is determined when the moving object crosses the left boundary in an approaching manner, and “someone departing” is determined when the moving object approaches the right boundary in a departing manner. Based on this solution, interference caused by the specified boundary being uniquely determined can be prevented.
[0115] Similarly, the communication module **5** is further configured to execute a command from an application program to change the specified boundary. The application may be an application program (app) running on an intelligent terminal (such as the electronic device **200**). In other words, the user can adjust the specified boundary via any intelligent terminal running the relevant application and establishing a communication connection with the communication module **5**, thereby changing the triggering condition of the fifth result to suit different application scenarios.
[0116] In the embodiment shown in FIG. **15**, the microwave sensing apparatus **100** further includes at least one switch module **34** for switching on/off a power supply circuit of an external electrical device. It is electrically connected to the communication module **5** to be switched on or off under the control of the communication module **5**. The communication module **5** is further configured to control the switch module **34** to switch on or off based on the sensing result according to a preset control logic, thereby controlling the power supply of the electrical device.
[0117] In a specific example, the switch module **34** includes a relay electrically connected to the power supply circuit of an external electrical device to control the power supply of the electrical device to be turned on or off under the control of the communication module **5**. Of course, the switch module **34** can also be implemented in other ways, not limited to this.
[0118] Additionally, to meet increasingly complex intelligent scene linkage requirements, an embodiment of the present invention provides a technical solution for diversified intelligent scene settings based on the communication module **5** of the microwave sensing apparatus **100** being connected to the designated network. Specifically, the communication module **5** is further configured to report the sensing result via the designated network in a state of being connected to the designated network, so that a gateway device and/or a cloud server **300** connected to the designated network can receive the sensing result and control a defined control result to be executed according to a target control relationship matching the sensing result in at least one pre-set control relationship; the control relationship defines a mapping relationship between at least one of a plurality of sensing results and at least one control result; and the control result is an executable function of one controlled device connected to the designated network. The controlled device may be, for example, any or a combination of a smart light, a smart speaker, a smart air conditioner, etc. Thus, based on the technical solution provided by this embodiment, the present invention can achieve diverse and complex intelligent linkage requirements by freely defining control relationships between various sensing results and executable functions of controlled devices connected to the designated network.
[0119] The control result may be an executable function of any one or more controlled devices connected to the designated network, including, for example, turning an electrical device on or off. In a specific example, the electronic device **200** is a mobile phone. After connecting to the designated network where the microwave sensing apparatus is located, any smart device bound to the mobile phone's app account can be selected to form the control relationship. The user can freely select relevant mapping relationships between each sensing result of the microwave sensing apparatus and executable functions of each smart device via the display interface of the electronic device **200** to determine the control relationship.
[0120] In some embodiments, the control result may also include changing the indication lamp

signal of the microwave sensing apparatus **100**. Thus, the microwave sensing apparatus **100** can link its own indication lamp signal while linking external electrical devices. For example, when the microwave sensing apparatus **100** detects a moving object, it turns on the corresponding light and turns off its own indication lamp. When no moving object is detected, it turns off the corresponding light and turns on its own indication lamp, minimizing unnecessary illumination of the indication lamp of the microwave sensing apparatus **100**.

[0121] Additionally, the inventors found that in daily intelligent scenarios, the illuminance parameter is also an important basis for linkage conditions. For example, in a smart light-on scenario, setting the microwave sensing apparatus **100** to turn on the light when detecting a person in the target sensing region would cause the light to turn on even during bright daylight, wasting electricity. Based on this, this embodiment further proposes a technical solution to address related issues. Referring to FIG. **16**, the microwave sensing apparatus **100** further includes a light sensing module **32** electrically connected to the communication module **5** for detecting illumination intensity. Thus, the communication module **5** can detect the current illumination intensity via the light sensing module **32** and send the detected illumination intensity to form a trigger condition for the control result in the control relationship.

[0122] Further, based on the technical solution provided by the above embodiments, in some embodiments, the communication module **5** is further configured to periodically acquire illumination intensity data via the light sensing module **32** and upload it, enabling the electronic device **200** to respond to the illumination intensity data and form a representation associated with the illumination intensity data on the display interface thereof FIG. **17** shows a representation of the illumination intensity on the display interface of the electronic device **200** in a specific example. As seen, the illumination intensity data for each time period is fitted to form a fitting curve, allowing users to intuitively view historical illumination intensity data and find reference points for setting control relationships in intelligent scenarios based on illumination intensity. Specifically, the communication module **5** is further configured to report the illumination intensity via the designated network when connected to it, enabling a gateway device and/or cloud server **300** connected to the designated network to receive the illumination intensity data and execute a defined control result according to a target control relationship matching the illumination intensity among at least one preset control relationship. The control relationship defines a mapping relationship between illumination intensity of at least one specified condition and at least one control result. The control result is an executable function of a controlled device connected to the designated network. The control relationship and control result in this embodiment can be understood with reference to the above embodiment and are not detailed here. The difference is that the trigger condition for intelligent scenarios in this embodiment is illumination intensity. Users can set reasonable mapping relationships based on illumination intensity values from each time period in the fitting curve, ensuring that the control results are executed more appropriately. For example, in a smart light-on scenario, if the microwave sensing apparatus **100** is set to turn on the light when detecting a person in the target sensing region and the illumination intensity is below 100 lux, it ensures that the light won't turn on during bright daylight even if a person is detected, but only when ambient light falls below 100 lux and becomes darker, avoiding energy waste.

[0123] Additionally, in some embodiments, to optimize the amount of illumination intensity data reported, the communication module **5** is further configured to upload acquired illumination intensity data at predetermined intervals, or upload the acquired illumination intensity data when the change between two consecutive acquisitions exceeds a specified threshold, enabling the electronic device **200** to respond to the illumination intensity data and form a representation associated with the illumination intensity data on the display interface thereof. Thus, based on this solution, the illumination intensity data is only reported when changes exceed a specified threshold or at predetermined intervals, not in real-time, significantly reducing data reporting when illumination intensity changes are minimal.

[0124] As shown in FIG. **13**, the light-emitting module **33** is electrically connected to the communication module **5** to emit an indication signal indicating the working state of the microwave sensing apparatus **100** under its control. The communication module **5** is further adapted to turn off the indication lamp in the light-emitting module **33** when acquiring illumination intensity via the light sensing module **32**. In other words, in this embodiment, the light sensing module **32** collects illumination intensity data and the light-emitting module **33** illuminates the indication lamp at intervals to prevent the indication lamp from affecting the accuracy of illumination intensity data during collection.
[0125] Further, the light-emitting module **33** includes an indication lamp. Similar to the above embodiment, the control result also includes changing the signal emitted by the indication lamp, allowing the microwave sensing apparatus **100** to link its own indication lamp signal while linking external electrical devices.
[0126] Similarly, as shown in FIG. **15**, the microwave sensing apparatus **100** further includes at least one switch module **34** for switching on/off a power supply circuit of an external electrical device. It is electrically connected to the communication module **5** to be turned on or off under the control of the communication module **5**. The communication module **5** is further configured to control the switch-on or switch-off of the switch module **34** with preset control logic based on the illumination intensity to control the power supply of the electrical device. The preset control logic may, for example, be turning on the electrical device when the illumination intensity is sensed to be lower than a preset value (e.g., turning on a lamp for illumination when the illumination intensity is lower than 500 lux), and turning off the electrical device otherwise.
[0127] Further, in a specific example, the switch module **34** includes a relay electrically connected to the power supply circuit of an external electrical device to control the power supply of the electrical device to be turned on or off under the control of the communication module **5**.
[0128] The light sensing module **32** in the above-mentioned embodiment specifically includes a visible light photoelectric probe and an infrared light photoelectric probe. The light sensing module **32** is configured to obtain the illumination intensity by processing the illumination data of the visible light photoelectric probe and the illumination data acquired by the infrared light photoelectric probe with a preset algorithm. In a specific example, the preset algorithm may be any one or more logical operations. In this embodiment, more accurate illumination intensity data is obtained by subtracting the illumination data acquired by the visible light photoelectric probe and the infrared light photoelectric probe, but is not limited thereto.
[0129] Furthermore, it should be noted that the communication module **5** can access the designated network in multiple ways to establish a communication connection with the electronic device **200**. An embodiment of the present invention provides a preferred implementation. Specifically, in this embodiment, the communication module **5** is further adapted to enter a network configuration mode in response to a designated network configuration operation to send out a designated network configuration signal such that a networked device receiving the designated network configuration signal instructs the communication module **5** to connect to the designated network in response to the designated network configuration signal, so as to establish a communication connection with at least one electronic device **200** having a display interface by the designated network in a state in which the communication module is connected to the designated network. The networked device may be the electronic device **200**, or may be a gateway device (such as a Bluetooth gateway or router) connected to a designated network. The specified network configuration operation may be a local operation, such as long-pressing a button to enter the network configuration mode, or performing a power-off restart to enter the network configuration mode. It should be understood that the network configuration signal can be sent out in multiple ways, such as through peer-to-peer communication (e.g., Bluetooth direct connection, Wi-Fi direct connection, NFC) to the electronic device **200**, or through non-peer-to-peer communication (e.g., broadcast) to the electronic device **200**. Moreover, the network configuration signal should at least include the source identifier (e.g., a

unique MAC address set at the factory) of the microwave sensing apparatus **100**.
[0130] The network configuration mode may be entered in an unconfigured state or may be entered by resetting in a configured state. In one example, the communication module **5** of the microwave sensing apparatus **100** is specifically adapted to determine that the communication module **5** enters the network configuration mode in response to at least one trigger signal caused by the specified network configuration operation in the unconfigured state. In another example, the communication module **5** of the microwave sensing apparatus **100** is specifically adapted to determine that the communication module **5** is reset and enters the network configuration mode in response to at least one trigger signal caused by the specified network configuration operation in the configured state.
[0131] In the network configuration mode, a network configuration message is generated and sent out, so that after receiving the network configuration message, the designated device instructs the microwave sensing apparatus **100** to join the designated network to complete the network configuration. The designated device includes an intelligent terminal device and/or a gateway device. After completing the network configuration, the microwave sensing apparatus **100** can communicate with the gateway device by the designated network, and further communicate with the electronic device **200** connected to the designated network by the gateway. In one example, the designated device is a mobile phone. After receiving the network configuration message, it sends the security information of the designated network (e.g., the name and password of the local area network) to the communication module **5** of the microwave sensing apparatus, and then the communication module **5** connects to the designated network based on the security information. Based on the above description, it should be understood that completing the network configuration mode should be understood as a mode in which the microwave sensing apparatus **100** can perform data transmission with the gateway device after successfully joining the designated network. Furthermore, this embodiment provides a preferred implementation for the network configuration of the microwave sensing apparatus **100**. Based on this implementation, the microwave sensing apparatus **100** can be quickly discovered by intelligent terminal devices and/or gateway devices based on the network configuration message sent after entering the network configuration mode, and then instructed to join the designated network, thereby improving the network access efficiency of the microwave sensing apparatus **100**. The instruction should include sending the name and password of an available network to the communication module **5**, so that the communication module **5** connects to the available network based on the name and password, thereby completing the relevant network configuration operations.
[0132] Correspondingly, in some embodiments, the communication module **5** is also configured to control a light-emitting module **33** connected to the communication module **5** to emit a first prompt signal before sending the network configuration message, so as to prompt the user that the microwave sensing apparatus **100** is about to enter the network configuration mode.
[0133] Further, to improve the success rate of network configuration, in some embodiments, when sending the network configuration message out, the communication module **5** is specifically configured to send the network configuration message once every specified network configuration interval.
[0134] Further, in some embodiments, during the network configuration, the communication module **5** is also configured to control a light-emitting module **33** connected to the communication module **5** to emit a second prompt signal. At least one of the following is different in the first prompt signal and the second prompt signal: flashing frequency; and color.
[0135] In a specific example, the first prompt signal is alternating red and blue LED flashing, and the second prompt signal is blue LED flashing at 500 ms intervals.
[0136] Based on the technical solution provided in this embodiment, the user can easily distinguish the current state of the microwave sensing apparatus **100** and confirm whether it has entered the network configuration mode based on the differences between the first prompt signal and the second prompt signal.

[0137] In some embodiments, to facilitate the user in knowing whether the network configuration of the microwave sensing apparatus **100** is successful, the communication module **5** is further configured to stop sending the network configuration message out and stop emitting the second prompt signal after successful network configuration. Thus, when the user observes the presence of the second prompt signal, it can be determined that the microwave sensing apparatus **100** is currently in the network configuration mode. When the second prompt signal disappears, it can be determined that the microwave sensing apparatus **100** has been successfully configured. In one example, the indication lamp signal of the communication module **5** in the microwave sensing apparatus **100** during the network configuration process is specifically manifested as follows. Before entering the network configuration mode and sending the network configuration message, the red and blue LEDs alternately flash for 300 ms (configurable as needed), then the network configuration message is broadcast and transmitted for 30 minutes, during which the blue LED flashs at 500 ms intervals. If the network configuration is successful within 30 minutes, the broadcast transmission and the blue LED flashing are terminated.
[0138] In some embodiments, to prevent the microwave sensing apparatus **100** from failing to report sensing results to the designated network for an extended period due to prolonged absence of trigger events, the communication module **5** is further configured to, when operating in the network configuration mode after completing network setup, periodically send reminder messages at predetermined intervals, thereby enabling the electronic device **200** and the gateway to verify the online status of the microwave sensing apparatus **100** upon receiving the reminder messages. The reminder message may only indicate that the microwave sensing apparatus **100** is online, or may include other functions, such as indicating the triggering state of a certain sensing result of the microwave sensing apparatus **100** to indirectly indicate that the microwave sensing apparatus **100** is online. In other words, the reminder message can be any trigger signal that allows the user to know that the microwave sensing apparatus **100** is currently online. In a specific example, the reminder message is embodied as a report message of the fourth result. For example, the unattended duration (fourth result) is uploaded every 30 seconds to indicate that the microwave sensing apparatus **100** is currently online.
[0139] Referring to FIG. **18**, another communication connection method between the communication module **5** and the electronic device **200** is specifically illustrated. In the embodiment shown in FIG. **18**, the communication module **5** is adapted to establish a communication connection with the electronic device **200** by peer-to-peer communication, and then generate a selected instruction corresponding to the selected operation based on different selected operations of at least one representation associated with the sensing parameter on the display interface of the electronic device **200**. The peer-to-peer communication method may be, for example, Wi-Fi Direct, BLE direct connection, or 433 MHz RF connection. Based on the technical solution provided in this embodiment, the user can establish peer-to-peer communication between the electronic device **200** (e.g., a smartphone) and the microwave sensing apparatus **100**, and then directly configure the sensing parameters of the sensing module **31** by the electronic device **200**. Specifically, the user can conveniently set the target sensing region of the microwave sensing apparatus **100** by the display interface shown on the electronic device **200**. The visual selected operation method allows the user to more accurately divide the target sensing region for specific application scenarios. Additionally, since the peer-to-peer communication is distance-limited, the configuration electronic device **200** and the microwave sensing apparatus **100** must be within a certain range (generally tens of meters). The configuration signal does not travel long distances, thereby preventing the configuration signal from being intercepted illegally and affecting the security of the microwave control device.
[0140] Different from the above embodiment where the electronic device **200** is separate from the microwave sensing apparatus **100**, as shown in FIG. **19**, in another embodiment, the electronic device **200** is integrated into the microwave sensing apparatus **100**, and the communication module

**5** is directly or indirectly electrically connected to the electronic device **200**. Furthermore, based on the technical solution provided by this embodiment, the user can conveniently select the sensing parameters of the sensing module **31** without relying on other devices, only by the electronic device **200** integrated with the microwave sensing apparatus **100**, thereby enabling easy selection of the target sensing region.

[0141] Further, in a specific implementation of the embodiment shown in FIG. **19**, the electronic device **200** includes a screen for displaying an interface, whereby the communication module **5** can generate selected instructions corresponding to different selected operations associated with at least one representation of the sensing parameter on the display interface of the screen. Thus, the users can conveniently set the target sensing region of the microwave sensing apparatus **100** by the display interface shown on the screen, and the visual selected operation facilitates more accurate division of the target sensing region for specific application scenarios.

[0142] Further, in another specific implementation of the embodiment shown in FIG. **19**, the electronic device **200** includes at least one actuator integrated into the microwave sensing apparatus **100**, the actuator being electrically connected to the communication module **5** to enable the communication module **5** to generate the selected instruction based on at least one trigger signal produced by the actuator in response to a selected operation. The actuator should be understood as a component or a collection of components capable of being manipulated to produce an action, such as buttons, knobs, etc. In one specific example, the actuator is implemented as a knob control. Accordingly, the following detailed descriptions are provided for several setting methods of the sensing parameters in the above embodiments. When the sensing parameter includes a maximum sensing distance, rotating the knob can output a trigger signal, which triggers the communication module **5** to generate a selected instruction for controlling the sensing module **31**, with clockwise rotation of the knob increasing the sensing distance and counterclockwise rotation of the knob decreasing the sensing distance. When the sensing parameter includes a minimum sensing distance, rotating the knob can output a trigger signal, which triggers the communication module **5** to generate a selected instruction for controlling the sensing module **31**, with the clockwise rotation of the knob increasing the minimum sensing distance and the counterclockwise rotation of the knob decreasing the minimum sensing distance. When the sensing parameter includes both maximum and minimum sensing distances, rotating the knob can output a trigger signal, which triggers the communication module **5** to generate a selected instruction for controlling the sensing module **31**, with the clockwise rotation of the knob increasing the maximum sensing distance, the counterclockwise rotation of the knob decreasing the maximum sensing distance clockwise rotation. When the knob is pressed, the clockwise rotation is used to increase the minimum sensing distance, and the counterclockwise rotation is used to reduce the minimum sensing distance. It should be noted that the implementation of the actuator is not limited to the knob and can include any other component capable of producing a selection action through physical manipulation, regardless of its specific configuration, without affecting the implementation of this solution.

[0143] Additionally, the inventors of the present invention have found that the sensing module **31** of conventional microwave sensing apparatuses **100** is prone to abnormal conditions such as crashes during operation, especially when initializing some parameters (distance resolution, sensitivity, the specified boundary, the specified time, segment range data, etc.) of the sensing module **31**, which can cause crashes. Once the sensing module **31** malfunctions, the entire microwave sensing apparatus **100** becomes non-functional. To address this technical issue in the prior art where the sensing module **31** crash leads to the microwave sensing apparatus **100** being unusable, an embodiment of the present invention provides related technical solutions. Specifically, as shown in FIG. **20**, in this embodiment, the communication module **5** controls the power-on/power-off of the sensing module **31** by a power management module **35** and is further configured to perform a power-off restart on the sensing module **31** via the power management module **35** when a specified condition indicating an abnormal working state of the sensing module

**31** is triggered. The specified condition indicates an abnormal working state of the sensing module **31**. In a specific example, the power-off restart involves power down for 2.5 seconds, and then restoring power and waiting 1.5 seconds before reinitializing the configuration of the sensing module **31**. Thus, the technical solution provided in this embodiment allows the sensing module **31** to be power-cycled via the software when it malfunctions, enabling quick reconfiguration to restore normal operation, thereby solving hardware crash issues through software means.

[0144] Further, the specified condition includes not receiving a sensing result from the sensing module **31** within a specified time. That is, when the communication module **5** does not receive the sensing result sent by the sensing module **31** within a specified time, the sensing module **31** is powered off and powered on successively by the power management module **35** and the sensing module **31** is restarted. In one specific example, the condition to trigger the abnormal working state may manifest as not receiving detection data from the sensing module **31** within 10 seconds (set based on actual needs).

[0145] Specifically, the power management module **35** described in the above embodiments includes a switching device connected between a power supply and the power terminal of the sensing module **31**, with a control terminal linked to the communication module **5**, enabling the communication module **5** to control the switching device to turn the power supply circuit of the sensing module **31** on or off. As shown in FIG. **21**, a specific circuit implementation of this embodiment includes a switching device including interconnected transistor Q1 and MOSFET Q2. Q1's electrode b is connected to the ON/OFF pin of the communication module, electrode c to ground, and electrode c to Q2's electrode G for controlling Q2's on/off state based on the ON/OFF of Q1. Q2's electrode s is electrically connected to a 5V supply, and electrode D to the power terminal of the sensing module **31**. Then based on the specific circuit, the control principle is as follows. When the ON/OFF pin of the communication module **5** is at a high level, the triode Q1 base has mA level current, the triode is conductive, and the collector voltage of Q1 is close to 0V. That is, the electrode G of Q2 is 0 V, the VGS is about-5 V, and the source drain of Q2 is conductive, so that the power is supplied to the sensing module **31**. When the MCU ON/OFF pin is at a low level, the triode Q1 base has no current, and the triode is cutoff. Q1 collector voltage is close to DC5V. That is, Q2's electrode G has a voltage of DC5V, VGS is about 0V, and the Q2 source drain is cutoff, so that the power cannot be supplied to the sensing module **31**, and then the sensing module **31** is powered off.

[0146] Additionally, the inventors found that merely powering off the sensing module **31**'s supply terminal often leaves its communication ports partially powered, causing restart failures. Thus, in an embodiment, the sensing module **31** communicates with the communication module **5** via a serial port, and the communication module **5** is further configured to pull the level of related pins low during power-off of the sensing module **31** to ensure complete shutdown of the sensing module **31**. Specifically, as shown in FIG. **21**, If only 5V power supply is turned off when the sensing module **31** is powered off, and UART_TX and UART_RX remain at a high level, the communication module's pins may backfeed voltage to the sensing module **31**, leaving its supply terminal at a half-high level. This prevents proper shutdown and subsequent restart. Thus, when turning off the 5V power supply to the module, the UART_TX and UART_RX pins is pulled to the low level. Therefore, in this embodiment, during a power-off restart of the sensing module **31**, not only is the power supply end turned off, but the serial transmit-receive ports (TX, RX) are also set at the low level at the software level to ensure complete power-off, improving restart success rates.

[0147] Further, in all the above embodiments, the sensing module **31** specifically includes a radar module that emits detection waves to form an actual sensing region (as shown by the outermost dotted line in FIG. **8**) which the detection waves can cover. The target sensing region (shaded region in FIG. **8**) is contained within this actual sensing region. The distance between the moving object and the sensing module **31** is calculated based on the delay time of the echo feedback of the detection wave by the moving object, and the actual sensing region is divided based on a number of specified paragraph ranges, thus forming various sensing parameters that can be selected by the user, and then associating these sensing parameters with the app application of the electronic device. Thus, a representation of an interface capable of receiving the user's selected operations is formed by the display interface of an app.

[0148] Further, in this embodiment, the communication module **5** specifically includes a Bluetooth module. The Bluetooth module establishes communication with the radar module via a serial port, establishes communication with the light sensing module **32** via IIC communication, controls each indication lamp in the light-emitting module **33** via input/output ports, and establishes a communication connection with the electronic device **200** by joining a designated network composed of a gateway. Thus, the Bluetooth module performs networking and data transmission via Bluetooth protocol to reduce product power consumption.

[0149] Moreover, the inventors of the present invention found that during the use of the microwave sensing apparatus, the users can control the power switch of the microwave sensing apparatus or its linkage with controlled devices such as lighting equipment by pressing the switch button of the microwave sensing apparatus. After linkage, the external light environment is detected by the configured light sensing region, and the sensing result is uploaded to the gateway device and/or cloud server to control the lighting equipment. Meanwhile, the users can also obtain the working state of the microwave sensing apparatus by the indication lamp on the microwave sensing apparatus. In existing microwave sensing apparatuses, the switch button setting region, the indication lamp setting region and the light sensing region are arranged separately, sometimes even on different side walls of the device, making it inconvenient for users. For example, when controlling the switch or network configuration of the microwave sensing apparatus, the users need to first locate the indication lamp position and then observe its illumination status to obtain the real-time working state of the device. Moreover, the housing of microwave sensing apparatuses typically has openings corresponding to the switch button, the indication lamp and the light sensing region, resulting in uneven housing thickness which significantly affects the performance of the sensing module and reduces practicality. Based on this, an embodiment of the present invention provides a related technical solution capable of solving this technical problem. Specifically, with reference to FIGS. **22** to **46**, in this embodiment, the microwave sensing apparatus **100** further includes a housing **1**, an optical transceiver **2**, a light sensing module **32** and a light-emitting module **33**. The housing **1** has a first wall **11**, and a detection switch **4**, the sensing module **31** and the communication module **5** are provided inside the housing **1**. The optical transceiver **2** is provided on the first wall **11**, enabling the microwave sensing apparatus **100** to emit light in a first direction and receive light in a second direction through the optical transceiver **2**. The optical transceiver **2** is configured to match the detection switch **4**, so as to trigger the detection switch **4** when displaced in response to a first operating force. The light sensing module **32** corresponds to the optical transceiver **2** and electrically connected to the communication module **5** for receiving light in the second direction to perform illumination intensity detection. The light-emitting module **33** corresponds to the optical transceiver **2** and electrically connected to the communication module **5** to emit light in the first direction under control of the communication module **5**, thereby forming an indication signal for indicating the working state of the microwave sensing apparatus **100**. The light sensing module **32** can detect external illumination intensity by receiving light in the second direction. The microwave sensing apparatus **100** can be interconnected with controlled devices such as external lighting equipment to transmit sensing results from both the sensing module **31** and the light sensing module **32**, enabling real-time control of the working state of controlled devices and providing users with an intelligent working and living environment. Additionally, the light-emitting module **33** can display the working state of the microwave sensing apparatus **100** (including its switch state, network configuration state, lighting state, etc.) by emitting light in the first direction through the optical transceiver **2**, thereby reminding users and facilitating operation. Both the light sensing module **32** and the light-emitting module **33** correspond to the optical transceiver **2**, meaning that their light sensing and indication functions are achieved by the light-transmitting performance of the optical transceiver **2**. Furthermore, the optical transceiver **2** can be displaced in response to a first operating force to trigger the detection switch **4**. In other words, the optical transceiver **2** also has a trigger function on the basis of the sensitive and indicating functions. This allows the detection switch **4** to generate a trigger signal, based on which the microwave sensing apparatus **100** switches its working state. In this way, the optical transceiver **2** integrates three functions: light sensing, indication, and triggering. The structural design of the microwave sensing apparatus **100** is compact and straightforward, eliminating the need for users to locate separate structures for each function, thereby enhancing usability. Compared to existing products, this invention integrates the functions of a switch button, indication lamp, and light sensing region into a single structure—the optical transceiver **2**. This not only simplifies the structure and improves the overall aesthetic appearance of the microwave sensing apparatus **100** but also reduces the number of openings in the housing **1** from three to one, improving the thickness uniformity of the first wall **11**. If the sensing module **31** corresponds to the first wall **11**, this arrangement can enhance sensing accuracy of the sensing module **31** while minimizing the adverse effects of housing openings on the sensing performance of the microwave sensing apparatus **100**. Moreover, in dark environments when the sensing module **31** detects human presence, the optical transceiver **2** is illuminated by light emitted in the first direction, allowing the users to clearly identify the position of the optical transceiver **2** and accurately operate the optical transceiver **2** to trigger the detection switch **4**, thereby enabling quick real-time control of the microwave sensing apparatus **100**.

[0150] It should be noted that the detection switch **4** may be a microswitch, a tact switch, a membrane switch, or a piezoelectric switch, etc. Specifically, in some embodiments of the present invention, the detection switch **4** is a microswitch, which offers high responsiveness and low power consumption.

[0151] It should also be noted that the first direction and the second direction are opposite directions. The first direction is from the interior to the exterior of the housing **1** (inside-to-outside direction), while the second direction is from the exterior to the interior of the housing **1** (outside-to-inside direction).

[0152] Additionally, the shape of the housing **1** is not limited. It may be cylindrical or rectangular. Correspondingly, the first wall **11** may be planar or curved. Specifically, referring to FIGS. **22-24** and **33-42**, in some embodiments of the present invention, the housing **1** is cylindrical with the first wall **11** being its planar top wall.

[0153] Meanwhile, the installation position of the microwave sensing apparatus **100** is not limited. The device can be fixed to a mounting surface on various installable objects including walls, ceilings, bookshelves, or beds, making it suitable for different application scenarios.

[0154] Specifically, the optical transceiver **2** includes an optical path channel that serves both to emit light in the first direction and receive light in the second direction. Referring to FIGS. **22-24**, **33-35**, **45** and **46**, the optical transceiver **2** includes a light-transmitting part **21** and a trigger part **22**. The optical path channel is formed within the light-transmitting part **21**, which includes an indication region **211** and a light sensing region **212**. The indication region **211** corresponds to the light-emitting module **33**, allowing light in the first direction emitted by the light-emitting module **33** to pass through the light-transmitting part **21** to the exterior of the housing **1**. The light sensing region **212** corresponds to the light sensing module **32**, enabling light in the second direction from outside the housing to enter through the light-transmitting part **21** for reception by the light-emitting module **33**. The trigger part **22** is provided on the light-transmitting part **21** and can be displaced relative to the first wall **11** under a first operating force, corresponding to the detection switch **4** to trigger the detection switch **4** upon displacement. Thus, while the light-transmitting part **21** serves both light sensing and indication functions, the addition of the trigger part **22** provides triggering capability. More specifically, the trigger part **22**, the light sensing region **212** and the indication region **211** are sequentially arranged along the length of the optical transceiver **2**.

[0155] It should be noted that the relative positions of the indication region **211** and light sensing region **212** are not limited. They may be separate or overlapping.

[0156] Further, referring to FIGS. **45** and **46**, in some embodiments, the indication region **211** and light sensing region **212** overlap, meaning the combined region of the indication region **211** and light sensing region **212** serves for both light incidence and emission. This reduces the required region of the light-transmitting part **21**, simplifies the structure, further decreases the housing opening size, and enhances the overall aesthetic of the microwave sensing apparatus **100**.

[0157] Additionally, the proximity of the light-emitting module **33** to the light sensing module **32** further reduces the area needed for the light-transmitting part **21** on the basis of realizing the transmittance and photosensitivity of the light-transmitting part **21**.

[0158] Specifically, in this invention, the light sensing module **32** is a light sensor, more particularly, a low-cost I2C digital light sensor, which converts light intensity into digital output signals compatible with **12**C interfaces. It provides linear response across a wide dynamic range from 0.01 lux to **64***k* lux, making it particularly suitable for high-ambient-light applications.

[0159] Specifically, in this invention, the light-emitting module **33** includes at least one indication lamp. More specifically, referring to FIG. **33**, in some embodiments of the present invention, two indication lamps are provided, the two being LED lights with different colors to distinguish different working states of the microwave sensing apparatus **100**. Furthermore, by setting different illumination durations and lighting patterns of the two indication lamps, more working states of the microwave sensing apparatus **100** can be matched to form different indication signals. For example, the indication lamp may flash for a long time or a short time, one of the two indication lamps may flash, or the two may flash alternately. For instance, alternating flashes of the two indication lamps once may be defined as power-on of the microwave sensing apparatus **100**. Rapid flashing (500 ms on, 500 ms off) of one indication lamp may be defined as network configuration of the microwave sensing apparatus **100**. Brief flashing of one indication lamp every 5 seconds for 300 ms may be defined as occupied from detection by the microwave sensing apparatus **100**. More specifically, one of the two indicator lights displays red light and the other displays blue light, allowing users to quickly distinguish between them.

[0160] In embodiments where the light-emitting module **33** is positioned adjacent to the light sensing module **32**, the two indication lamps are positioned adjacent to the light sensing module **32** on both sides of the light sensing module **32**, with distances typically ≤3 mm between the two indication lamp and the light sensing module **32** to achieve “adjacent” placement.

[0161] Specifically, referring to FIGS. **22-24**, **33**, **34**, **45** and **46**, the light-transmitting part **21** includes a light guide member **213** with first and second end surfaces **2131**, **2132** provided on both ends of the light guide member **213**. The outward-facing first end surface forms either the indication region **211** (the second end surface **2132** is provided inwards and close to the light-emitting module **33**) or the light sensing region **212** (the second end surface **2132** is provided inwards and close to light sensing module **32**). The light guide member **213** collects and directs light, reducing transmission loss and improving display brightness. Specifically, when the first end surface **2131** of the light guide member **213** is provided outwards to form the light sensing region **212**, and the second end surface **2132** is provided inwards and close to the light sensing module **32**, the light sensing region **212** has a light diffusion effect, facilitating the light sensing module **32** to receive light from the second direction. When the first end surface **2131** is provided outwards to form the indication region **211**, and the second end surface **2132** is provided inwards and close to the light-emitting module **33**, the indication region **211** has a light reflection effect, and light from the first direction is uniformly emitted through the indication region **211** with enhanced brightness, making the indication region **211** clearly visible with excellent prompting effect.

[0162] Note that the light guide member **213** may take various forms such as a light guide column or film, without limitation. Specifically, referring to FIGS. **22-24**, **33**, **34**, **45**, and **46**, in some

embodiments of the present invention, the light guide member **213** is a light guide column to further reduce light loss during propagation. It should also be noted that the number of light guide members **213** is not limited. Two light guide members **213** may be provided, where a first end surface **2131** of one light guide member **213** forms the indication region **211** with its second end surface **2132** adjacent to the light-emitting module **33**, while a first end surface **2131** of the other forms the light sensing region **212** with its second end surface **2132** adjacent to the light sensing module **32**. Alternatively, referring to FIGS. **22-24**, **33**, **34**, **45**, and **46**, based on the embodiment where "the indication region **211** and light sensing region **212** overlap, and the light-emitting module **33** is provided adjacent to the light sensing module **32**", one single light guide member **213** may be used, where its first end surface **2131** forms both the indication region **211** and the light sensing region **212**, and its second end surface **2132** is adjacent to both the light-emitting module **33** and the light sensing module **32**. This simplifies the structure of the microwave sensing apparatus **100** and reduces costs.
[0163] Furthermore, based on the above embodiment where "the indication region **211** and light sensing region **212** are overlapping, the light-emitting module **33** is provided adjacent to the light sensing module **32**, the first end surface **2131** of the light guide member **213** forms both the indication region **211** and light sensing region **212**, and the second end surface **2132** of the light guide member **213** is adjacent to both the light-emitting module **33** and light sensing module **32**", if the second end surface **2132** corresponds to both the light-emitting module **33** and light sensing module **32**, the setting area of the second end surface **2132** would be larger. If the first end surface **2131** has the same area as that of the second end surface **2132**, the first end surface would also be larger, potentially exposing internal electronic components (including the light sensing module **32**, the light-emitting module **33**, etc.) inside the housing **1**, so that the user can clearly see the structure of the internal electronic components from the outside of the housing **1**, affecting the overall aesthetic appearance of the microwave sensing apparatus **100**. Therefore, in some embodiments, the second end surface **2132** has a smaller area than that of the first end surface **2131** and corresponds to the light sensing module **32**, ensuring both light sensing performance of the light sensing module **32** and indication effects of the indication region **211** while minimizing component exposure inside the housing **1**. Specifically, depending on the size of the light sensing module **32** and the distance between the light sensing module **32** and the light-emitting module **33**, the first end surface **2131** may have a diameter of 4 mm and the second end surface **2132** have a diameter of 2 mm.
[0164] It should be noted that the configuration form for making the area of the second end surface **2132** smaller than that of the first end surface **2131** is not limited. For example, the light guide member **213** may be tapered from its first end surface **2131** to its second end surface **2132**, so that the area of the second end surface **2132** is smaller than that of the first end surface **2131**. However, with such configuration, the overall volume of the light guide member **213** tends to be thicker in terms of production process, which may introduce bubbles during injection molding, affecting the light-guiding effect of the light guide member **213** and causing off-center and uneven illumination from the light-emitting module **33**. To address this, referring to FIGS. **23**, **34**, and **45**, in some embodiments of the present invention, the light guide member **213** is sequentially provided with a first light guide part **2133** and a second light guide part **2134** along the inner-outer direction. The first light guide part **2133** is provided as a frustum, with the first end surface **2131** formed on a side of the first light guide part **2133** away from the second light guide part **2134** and a generatrix of the first light guide part **2133** provided as a concave arc. The second light guide part **2134** is provided as a cylinder, with the second end surface **2132** formed on a side of the second light guide part **2134** away from the first light guide part **2133**, and an area of the second end surface **2132** is equal to an area of a side of the first light guide part **2133** adjacent to the second light guide part **2134**. This configuration not only prevents exposure of electronic components inside the housing **1**, but also reduces bubble generation rate during production due to the slender design of the second light

guide part **2134**, thereby enhancing light guiding effect of the light guide member **213** and enabling centered and uniform display of light from the light-emitting module **33** in the indication region **211** of the optical transceiver **2**.

[0165] Specifically, referring to FIG. **24**, in some embodiments, the trigger part **22** is implemented as a trigger post **221** that abuts or is close to the detection switch **4**. When displaced by the first operating force, it triggers the detection switch **4**, enabling operations like power-on or network configuration for the microwave sensing apparatus **100** by the user pressing the trigger part **22**. More specifically, based on the arrangement where "the trigger part **22**, the light sensing region **212**, and indication region **211** are sequentially distributed along the length of the optical transceiver **2**; the indication region **211** and the light sensing region **212** overlap; the light-emitting module **33** is provided adjacent to the light sensing module **32**; and the first end surface **2131** of the light guide member **213** face outwards to form the indication region **211** and the light sensing region **212**, and the second end surface **2132** face inwards and is close to the light-emitting module **33** and the light sensing module **32**", the trigger post **221** and light guide member **213** are sequentially distributed along the length direction of the optical transceiver. Specifically, in the present invention, the trigger part **22** can not only be displaced from an initial position to a trigger position under the first operating force to trigger the detection switch **4**, but also return from the trigger position to the initial position under a reset force after triggering the detection switch **4**. However, if the reset force is excessive, it may cause the trigger part **22** to have overdisplacement. Thus, after the trigger part **22** is reset to the initial position, it continues to move to a protruding position away from the housing **1**, which affects the user's subsequent feeling of use and also affects the aesthetic appearance of the microwave sensing apparatus **100**. It should be noted that the reset force can be understood as either another operating force applied by the user to the trigger part **22** after removal of the first operating force, or the elastic reset force exerted by the detection switch **4** on the trigger part **22** due to its elasticity after removal of the first operating force.

[0166] To address this, the present invention provides a limiting portion for restricting the movement range of the trigger part **22**. More specifically, referring to FIGS. **22**, **23**, and **33-38**, in some embodiments of the present invention, the first wall **11** is provided with a mounting hole **111**. The light-transmitting part **21** includes a pressing portion **214** and a bearing portion **215** stacked along its thickness direction, where the surface area of the pressing portion **214** is smaller than that of the bearing portion **215**. The pressing portion **214** is adaptively provided in the mounting hole **111**, while the bearing portion **215** is provided inside the housing **1**. This means the surface area of the bearing portion **215** is larger than the hole area of the mounting hole **111**. Therefore, when the trigger part **22** resets, the movement of the bearing portion **215** towards the mounting hole **111** is restricted by contact with the first wall **11** of the housing **1**, preventing it from moving into the mounting hole **111** or protruding outside the housing **1** through the mounting hole **111**, thereby indirectly limiting the movement range of the light-transmitting part **21**. More specifically, when the trigger part **22** is in the initial position, the bearing portion **215** abuts against the first wall **11**, further reducing the movement range of the light-transmitting part **21** to ensure precise reset of the trigger part **22** and improve user experience.

[0167] Specifically, in the present invention, since the trigger part **22** is provided on the light-transmitting part **21**, the trigger part **22** activates the detection switch **4** by moving relative to the housing **1** in response to the first operating force. This can be understood as either the light-transmitting part **21** rotating relative to the housing **1** to drive the trigger part **22** to activate the detection switch **4**, or the light-transmitting part **21** moving linearly relative to the housing **1** to drive the trigger part **22** to activate the detection switch **4**. Accordingly, the connection between the light-transmitting part **21** and the housing **1** varies.

[0168] Specifically, in some embodiments of the present invention, the light-transmitting part **21** is pivotally connected to the housing **1**, enabling the light-transmitting part **21** to rotate relative to the housing **1** about an axis extending along the third direction. The third direction is parallel to the

horizontal direction of the light-transmitting part **21**. When the light-transmitting part **21** is subjected to the first operating force and undergoes pivotal movement, it drives the trigger part **22** to perform pivotal movement and activates the detection switch **4** by moving towards it.
[0169] Referring to FIGS. **1**, **33**, **35**, **45**, and **46**, the third direction is F1.
[0170] Further, a rotating shaft **24** and a pivot hole **1121** are provided between the light-transmitting part **21** and the housing **1**, with one of the rotating shaft **24** and the pivot hole **1121** provided on the light-transmitting part **21** and the other on the housing **1**, so that the light-transmitting part **21** is pivotally connected to the housing **1**, facilitating the assembly or disassembly of the optical transceiver **2** and the housing **1**.
[0171] According to the present invention, the rotating shaft **24** may be provided in the light-transmitting part **21**, and the pivot hole **1121** may be provided in the housing **1**. Of course, the rotating shaft **24** may be provided in the housing **1**, and the pivot hole **1121** may be provided in the light-transmitting part **21**. Specifically, referring to FIG. **24**, in some embodiments of the present invention, the light-transmitting part **21** is provided with the rotating shafts **24** on opposite sides in the third direction, and the first wall **11** is provided with two fixing bases **112** spaced apart in the third direction, each of the fixing bases **112** being provided with the pivot hole **1121**. The rotating shafts **24** are provided on the light-transmitting part **21**, and the pivot holes **1121** are provided on the first wall **11**, facilitating the quick assembly and disassembly of the light-transmitting part **21** and the first wall **11**, while the setting of the fixing bases **112** enhances the rotational stability of the light-transmitting part **21**. Further, referring to FIG. **24**, in some embodiments of the present invention, each of the fixing bases **112** is provided with two limiting ribs **113** protruding towards the other fixing base **112**, the two limiting ribs **113** being provided on opposite sides of the pivot hole **1121** in the fourth direction. The fourth direction is perpendicular to the third direction in the horizontal plane. The setting of the limiting ribs **113** improves the rotational stability of the light-transmitting part **21**, preventing the rotating shaft **24** from disengaging from the pivot hole **1121** during pivotal movement relative to the fixing base **112**.
[0172] Referring to FIGS. **1**, **33**, **35**, **45**, and **46**, the fourth direction is F2.
[0173] Specifically, according to the above, when the trigger part **22** is in the initial position, at least part of the light-transmitting part **21** is accommodated in the mounting hole **111**. In this case, when the light-transmitting part **21** is pivotally connected to the housing **1**, during the rotation of the light-transmitting part **21**, the part of the light-transmitting part **21** accommodated in the mounting hole **111** may interfere with the inner side wall of the mounting hole **111** during rotation, affecting the rotation of the light-transmitting part **21**, causing jamming during user operation and inconvenience to the user. Therefore, in some embodiments of the present invention, the mounting hole **111** is tapered from its end surface near the interior of the housing **1** to its end surface away from the interior of the housing **1**. That is, corresponding to the rotation stroke of the light-transmitting part **21**, the housing **1** is provided with an avoidance region for the part of the light-transmitting part **21** accommodated in the mounting hole **111**, thereby avoiding interference between the inner side wall of the mounting hole **111** and the light-transmitting part **21** during rotation, ensuring smooth rotation of the light-transmitting part **21** and improving the user experience.
[0174] Specifically, the light-transmitting part **21** rotates relative to the housing **1**, and the movement directions of the opposite ends of the light-transmitting part **21** in the fourth direction are opposite. One end is subjected to a force moving towards the interior of the housing **1**, i.e., pressed downwards, while the other end is subjected to a force moving towards the exterior of the housing **1**, i.e., lifted upwards. More specifically, referring to FIG. **45**, in some embodiments of the present invention, the trigger part **22** is provided at one end of the light-transmitting part **21** in the fourth direction, and the indication region **211** and the light sensing region **212** are provided at the other end of the light-transmitting part **21** in the fourth direction. Based on the above embodiment where "the light-transmitting part **21** includes a pressing portion **214** and a bearing portion **215**

stacked along its thickness direction, the surface area of the pressing portion **214** is smaller than that of the bearing portion **215**, and the pressing portion **214** is adapted to be provided in the mounting hole **111**, while the bearing portion **215** is provided inside the housing **1**," the bearing portion **215** has a first side surface **2151** connected to the pressing portion **214**, the first side surface **2151** has a first bearing surface **21511** corresponding to the indication region **211** and the light sensing region **212** of the light-transmitting part **21**, and a second bearing surface **21512** corresponding to the trigger part **22**. That is, when the light-transmitting part **21** rotates relative to the housing **1** and the trigger part **22** triggers the detection switch **4**, the trigger part **22**, i.e., the second bearing surface **21512**, is pressed downwards, while the indication region **211** and the light sensing region **212**, i.e., the first bearing surface **21511**, are lifted upwards. Further, the trigger part **22** moves between an initial position and a trigger position. When the trigger part **22** is in the initial position, the bearing portion **215** may be provided to abut against the first wall **11** or to have a gap with the first wall **11**. However, when the trigger part **22** is in the initial position and the bearing portion **215** is provided to abut against the first wall **11**, during the process of the trigger part **22** being pressed to trigger the detection switch **4**, the first bearing surface **21511** may interfere with the first wall **11**, preventing the light-transmitting part **21** from rotating and thus affecting the movement of the trigger part **22**. Therefore, in some embodiments of the present invention, when the trigger part **22** is in the initial position, there is a movement gap between the first bearing surface **21511** and the inner side surface of the first wall **11**. In this way, during the process of the trigger part **22** triggering the detection switch **4**, the first bearing surface **21511** can rotate relative to the housing **1** by means of the movement gap, ensuring smooth user operation. Further, to achieve the miniaturization design of the microwave sensing apparatus **100**, when the trigger part **22** is in the initial position, the first bearing surface **21511** is provided closer to the interior of the housing **1** compared to the second bearing surface **21512**, and the second bearing surface **21512** abuts against the first wall **11**. This reduces the space occupied by the bearing portion **215** inside the housing **1** while ensuring that the first bearing surface **21511** can rotate relative to the housing **1** for smooth user operation, thereby reducing the volume of the housing **1**. More specifically, in an embodiment of the present invention, the maximum trigger stroke of the detection switch **4** is 0.2 mm. When the trigger part **22** is in the initial position, the trigger part **22** abuts against the detection switch **4**. Accordingly, the movement gap between the first bearing surface **21511** and the inner side surface of the first wall **11** is set to 0.25 mm.
[0175] Specifically, the rotating shaft **24** and the pivot hole **1121** correspond to the junction of the first bearing surface **21511** and the second bearing surface **21512** or corresponding to the first bearing surface **21511**. This ensures that during the rotation of the light-transmitting part **21**, the trigger part **22** can be fully pressed downwards, i.e., the trigger part **22** rotates to the correct position to fully trigger the detection switch **4**, avoiding failure of the detection switch **4**. At the same time, during the rotation of the light-transmitting part **21**, the part corresponding to the light sensing module **32** and/or the light-emitting module **33** is prevented from being pressed downwards and acting on the light sensing module **32** and/or the light-emitting module **33**, thereby avoiding damage to the light sensing module **32** and/or the light-emitting module **33** due to excessive pressing or repeated use, which would affect their service life.
[0176] Of course, in other embodiments of the present invention, the light-transmitting part **21** moves relative to the housing **1** to drive the trigger part **22** to trigger the detection switch **4**. Specifically, the light-transmitting part **21** is provided with an elastic connection structure **23**, which is connected to the housing **1**. The elastic connection structure **23** can elastically stretch and compress due to its elasticity. That is, when the trigger part **22** is pressed downwards by the first operating force, the elastic connection structure **23** is elastically compressed, allowing the trigger part **22** to move towards the interior of the housing **1** to trigger the detection switch **4**. When the first operating force is removed, the elastic connection structure **23** generates an elastic reset force to elastically stretch and act on the trigger part **22**, causing it to move towards the exterior of the

housing **1** to return to the initial position.

[0177] It should be noted that the connection method between the elastic connection structure **23** and the housing **1** is not limited and may include snap connection, adhesive connection, etc.

[0178] Further, referring to FIGS. **22-24**, **33**, **45**, and **46**, in some embodiments of the present invention, the elastic connection structure **23** includes at least two elastic connection arms **231**. The two elastic connection arms **231** are provided on opposite sides of the light-transmitting part **21**. The inner surface of the first wall **11** is provided with two heat-melting posts **114**, which are thermally fused to their corresponding elastic connection arms **231** respectively. That is, the elastic connection structure **23** is fixedly connected to the housing **1** by thermal fusion connection, ensuring a stable connection.

[0179] It should be noted that when the elastic connection arms **231** are thermally fused to the heat-melting posts **114**, the high fusion temperature may damage other side walls of the housing **1** if the heat-melting posts **114** are close to any side wall other than the first wall **11**, affecting the quality and aesthetic appearance of the housing **1**. Therefore, in some embodiments of the present invention, each heat-melting post **114** is provided close to the middle of the first wall **11**, i.e., away from other side walls of the housing **1**, to prevent damage to other side walls and improve the aesthetic appearance of the housing **1**.

[0180] It should also be noted that the form of the elastic connection arms **231** is not limited. They may be straight or curved. Specifically, in some embodiments of the present invention, the elastic connection arms **231** are curved, making them more prone to elastic deformation under force and easier for users to operate.

[0181] Of course, in the present invention, the above two technical features may be set separately or simultaneously. Specifically, referring to FIGS. **24** and **34**, in some embodiments of the present invention, the above two technical features are set simultaneously, i.e., each heat-melting post **114** is provided close to the middle portion of the first wall **11**, and the elastic connection arm **231** is provided in a curved shape. This not only ensures thermal fusion connection effect between the elastic connection arm **231** and the heat-melting post **114**, improving the quality and aesthetic appearance of the microwave sensing apparatus **100**, but also facilitates user operation. It should be noted that in the present invention, the two technical features of "the light-transmitting part **21** is pivotally connected to the housing **1**, so that the light-transmitting part **21** can rotate relative to the housing **1** about an axis extending in the third direction, the third direction being parallel to the horizontal direction of the light-transmitting part **21**" and "an elastic connection structure **23** is provided between the light-transmitting part **21** and the housing **1**, and the elastic connection structure **23** is connected to the housing **1**" may be set separately or simultaneously. Specifically, in some embodiments of the present invention, the above two technical features are set simultaneously. Further, the elastic connection structure **23** corresponds to the trigger part **22**, and the rotating shaft **24** and the pivot hole **1121** correspond to the junction of the first bearing surface **21511** and the second bearing surface **21512**. That is, when the trigger part **22** is subjected to the first operating force, the light-transmitting part **21** can pivot relative to the housing **1**, and by the compression of the elastic connection structure **23**, the trigger part **22** can be pressed inwards to trigger the detection switch **4**, while the indication region **211** and the light sensing region **212** are lifted outwards. When the first operating force is removed, the trigger part **22** is subjected to the elastic force of the elastic connection structure **23** to return to the initial position, and the indication region **211** and the light sensing region **212** also return to their original positions, completing the operation. This improves the rotational stability of the light-transmitting part **21**, while the trigger part **22** can automatically reset by the elastic connection structure **23**, making the user operation very effortless. Specifically, in the present invention, the material of the light-transmitting part **21** is a transparent material, which has good light transmittance, allowing the light-transmitting part **21** to not only transmit light in the second direction to be received by the light sensing module **32** but also to display the light in the first direction clearly and brightly in the indication region **211**.

Further, the transparent material may be transparent glass or transparent PC plastic. Specifically, in some embodiments of the present invention, the material of the light-transmitting part **21** is transparent PC plastic, which has low production cost and elasticity. Compared to the transparent glass, it is less prone to damage upon collision or falling, offering high practicality.

[0182] Further, referring to FIGS. **22**, **23**, **33**, and **35**, the optical transceiver **2** further includes a decorative member **25**, which is provided on a side of the light-transmitting part **21** away from the interior of the housing **1** and includes a shielding region **251** and a light-transmitting region **252**. The shielding region **251** corresponds to the trigger part **22**, and the light-transmitting region **252** corresponds to the light sensing region **212** and the indication region **211**. The setting of the shielding region **251** prevents excessive exposure of the internal electronic components of the housing **1** and facilitates user identification of the positions of the trigger part **22**, the light sensing region **212**, and the indication region **211**. More specifically, in some embodiments of the present invention, the decorative member **25** is adhesively bonded to the light-transmitting part **21**, simplifying assembly. Further, during the assembly of the decorative member **25** and the light-transmitting part **21**, the misassembly may occur due to positioning accuracy issues, leaving part of the light-transmitting part **21** uncovered by the decorative member **25**, exposing some internal electronic components of the housing **1** and affecting the appearance. To address this, referring to FIGS. **33** and **35**, the first wall **11** is provided with a mounting hole **111**. The light-transmitting part **21** includes a pressing portion **214** and a bearing portion **215** stacked along its thickness direction. The surface area of the pressing portion **214** is smaller than that of the bearing portion **215**, and the pressing portion **214** is adapted to be provided in the mounting hole **111**, while the bearing portion **215** is provided inside the housing **1**. The decorative member **25** corresponds to the pressing portion **214** and is adapted to the mounting hole **111**. Thus, the surface area of the decorative member **25** is larger than that of the pressing portion **214**, offsetting the impact of positioning errors during the assembly of the decorative member **25** and the light-transmitting part **21** and ensuring that the light-transmitting part **21** is completely covered by the decorative member **25**, preventing exposure of the internal electronic components of the housing **1**.

[0183] Specifically, in some embodiments of the present invention, the decorative member **25** is an acrylic sheet, and the shielding region **251** of the acrylic sheet is formed by screen printing. The acrylic sheet has low cost but good transparency and light transmission properties. Therefore, by screen printing part of the acrylic sheet to form the shielding region **251**, it cannot only avoid exposing the structure of electronic components inside the housing **1**, but also improve the aesthetic appearance of the optical transceiver **2**.

[0184] Specifically, referring to FIGS. **22**, **25**, **33-36** and **41**, the microwave sensing apparatus **100** further includes a PCB board **6**, where the communication module **5**, the detection switch **4**, the sensing module **31**, the light-emitting module and the light sensing module **32** are provided on the PCB board **6** to transmit the acquired sensing results out. In the present invention, the external transmission can be to a remote server, a user terminal (e.g., a mobile phone, a computer, etc.), or to a gateway for forwarding by the gateway. Those skilled in the art can set specific transmission targets according to requirements, and the present disclosure is not specifically limited. That is, the microwave sensing apparatus **100** achieves network configuration based on the triggering state of the detection switch **4**, and after the network configuration is completed, transmits the sensing results of the sensing module **31** and the light sensing module **32** to an external remote server, user terminal or external gateway to correspondingly control the working state of a controlled device. Additionally, it can also control the working state of the light-emitting module **33** according to its different working states, providing users with an intelligent working and living environment.

[0185] It should be noted that the communication module **5** can be a Bluetooth module, a Wi-Fi module, etc. In some embodiments of the present invention, the communication module **5** is a Bluetooth module, which has both control and Bluetooth communication functions. It also can connect to the cloud, and control other electronic devices by the automated scenarios configured by the Mi Home APP.

[0186] More specifically, the PCB board **6** includes a first PCB board **6**, which is provided opposite to the first wall **11**. The detection switch **4**, the light sensing module **32** and the light-emitting module **33** are provided on the first PCB board **6** to correspond with the optical transceiver **2**. If the life presence sensor corresponds to the first wall **11**, it is provided on the first PCB board **6**. If it corresponds to the second wall **15**, when the second wall **15** is opposite to the first wall **11**, the life presence sensor is also provided on the first PCB board **6**. When the second wall **15** is adjacently connected to the first wall **11**, the PCB board **6** further includes a second PCB board **6**, with a certain angle between the first PCB board **6** and the second PCB board **6**. In this case, the life presence sensor is provided on the second PCB board **6**. More specifically, referring to FIG. **22**, in some embodiments of the present invention, the life presence sensor corresponds to the first wall **11**, thereby simplifying the internal structure of the microwave sensing apparatus **100** and reducing production costs.

[0187] Further, the microwave sensing apparatus **100** also includes a power supply unit **7**, which is electrically connected to the PCB board **6** to supply power to the communication module **5**, the detection switch **4**, the sensing module **31**, the light-emitting module and the light sensing module **32**, achieving electrical connection among the communication module **5** and the detection switch **4**, the sensing module **31**, the light-emitting module and the light sensing module **32**.

[0188] It should be noted that in the present invention, the power supply method of the microwave sensing apparatus **100** is not limited.

[0189] Specifically, in some embodiments of the present invention, the power supply unit **7** includes a power cord, with one end electrically connected to the PCB board **6** and the other end extending out of the housing **1** via a first through hole opened in the housing **1** to connect to an external power source. Moreover, when the power cord is subjected to a large pulling force, it may easily have poor contact or even disconnect from the PCB board **6**, affecting the power supply effect. Therefore, further, in some embodiments of the present invention, an anti-drop post is provided inside the housing **1** for winding part of the power cord, thereby transferring part of the pulling force to the anti-drop post, reducing the force on the connection part between the power cord and the PCB board **6**, and extending the service life.

[0190] It should be noted that in the present invention, the arrangement of the anti-drop post is not limited. The anti-drop post can be provided on the side wall of the housing **1** or on the PCB board **6**. Specifically, in some embodiments of the present invention, the anti-drop post is provided on a side wall of the housing **1**, providing high stability.

[0191] Specifically, referring to FIGS. **35**, **36** and **41**, in some embodiments of the present invention, the power supply unit **7** includes a power board **71**, which is electrically connected to the PCB board **6** via PIN pins. The power board **71** is provided with a wiring port **72**, which is electrically connected to an external wire by a second through hole **161** opened in the housing **1**. This power supply method is high-voltage power supply, ensuring stable power supply.

[0192] Meanwhile, in the present invention, the gateway includes a wireless communication gateway (e.g., Xiaomi speaker) and a power line carrier communication gateway. The microwave sensing apparatus **100** is wirelessly connected to the wireless communication gateway, which only has communication functions, while the microwave sensing apparatus **100** is wired to the wireless communication gateway, meaning the communication module **5** can be electrically connected to the power line carrier communication gateway via the wiring port **72**. The power line carrier communication gateway also has a power load function, i.e., a power supply function. Therefore, the microwave sensing apparatus **100** can be powered by the power line carrier communication gateway, thereby reducing the number of terminals in the wiring port **72**. Additionally, the linkage between the microwave sensing apparatus **100** and the controlled device can be achieved by an external gateway or by direct electrical connection with the controlled device, i.e., the wiring port **72** is electrically connected to the controlled device to realize the linkage between the microwave sensing apparatus **100** and the controlled device. More specifically, referring to FIG. **37**, in some embodiments of the present invention, the wiring port **72** has two terminals, which can be connected to the live and neutral wires of the power line carrier communication gateway for power supply and communication, or connected to the live and neutral wires of an external power supply line for power supply. Referring to FIG. **44**, in other embodiments of the present invention, the wiring port **72** has four terminals, which can be connected to an external power cord, or part of the terminals can be connected to an external power supply line while the other part is connected to the controlled device. In this case, the microwave sensing apparatus **100** is wirelessly connected to an external gateway. Of course, part of the terminals can also be connected to the power line carrier communication gateway while the other part is connected to the controlled device.

[0193] Specifically, to facilitate connecting external wires to the wiring port **72**, the second through hole **161** is gradually expanded in the inward and outward directions, making it easier for users' fingers to reach inside the housing **1** to connect external wires.

[0194] Specifically, referring to FIGS. **33** and **34**, in some embodiments of the present invention, the power supply unit **7** includes a USB module **73** provided on the PCB board **6**. The housing **1** is provided with a USB socket **12** corresponding to the USB module **73** for inserting a USB charging cable to electrically connect with the USB module **73**, making charging convenient. When the USB charging cable fails to supply power due to breakage, short circuit, etc., it can be directly replaced with a new one, which is simple, convenient and low-cost for maintenance.

[0195] Furthermore, the interface of the USB module **73** can be of different types, and correspondingly, the USB charging cable and the USB socket **12** also have matching types. The USB module **73** interface can be Type-A, Type-B, Type-C, etc. Currently, the Type-C interface is more universal. Therefore, in some embodiments of the present invention, the USB module **73** interface is set as Type-C. Correspondingly, the USB socket **12** is adapted as a Type-C socket, and the USB charging cable is a Type-C charging cable.

[0196] Additionally, in the present invention, the installation form of the PCB board **6** is not limited. It can be plugged into the housing **1**, snapped into the housing **1**, or fastened to the housing **1**, etc. Specifically, in some embodiments of the present invention, at least one limiting post **13** is protruded on a side wall of the housing **1** corresponding to the PCB board **6**. The PCB board **6** is provided with a limiting hole **61** corresponding to the limiting post **13**, and the limiting hole **61** is adapted to the limiting post **13** for inserting the limiting post **13**, making the installation simple. More specifically, referring to FIGS. **24** and **25**, in some embodiments of the present invention, the limiting post **13** is a cross post to enhance the limiting effect.

[0197] Specifically, in some embodiments of the present invention, at least one first threaded post **14** is protruded on a side wall of the housing **1** corresponding to the PCB board **6**. The PCB board **6** is provided with a first screw **62** adapted to the first threaded post **14**, so that the PCB board **6** is threadedly connected to the housing **1** via the first threaded post **14** and the first screw **62**, ensuring stable installation of the PCB board **6**.

[0198] It should be noted that in the present invention, the above two technical features can be set alternatively or simultaneously. Specifically, referring to FIGS. **24** and **25**, in some embodiments of the present invention, the above two technical features are set simultaneously, i.e., at least one limiting post **13** is protruded on a side wall of the housing **1** corresponding to the PCB board **6**, and the PCB board **6** is provided with a limiting hole **61** corresponding to the limiting post **13**, with the limiting hole **61** adapted to the limiting post **13** for inserting the limiting post **13**. Additionally, at least one first threaded post **14** is protruded on a side wall of the housing **1** corresponding to the PCB board **6**, and the PCB board **6** is provided with a first screw **62** adapted to the first threaded post **14**, so that the PCB board **6** is threadedly connected to the housing **1** via the first threaded post **14** and the first screw **62**. The height of the first threaded post **14** is less than that of the limiting post **13**, further improving the installation stability of the PCB board **6**, thereby enhancing the installation stability of electronic components on the PCB board **6** and improving the sensing effect of the sensing module **31**. The first threaded post **14** also has a supporting function to support the PCB board **6**, thereby defining the distance between electronic components on the PCB board **6** and the corresponding side wall of the PCB board **6**.

[0199] More specifically, referring to FIGS. **24** and **25**, in some embodiments of the present invention, the limiting post **13** is connected to the first threaded post **14**, thereby increasing the strength of both the limiting post **13** and the first threaded post **14**.

[0200] Of course, when the power supply unit **7** includes the power board **71**, and when the high-voltage power supply method is selected, the installation form of the power board **71** can also be the same as that of the PCB board **6**, and they are positioned and fixed by setting the limiting posts **13** and/or screws.

[0201] Further, based on the above embodiment where "an elastic connection structure **23** is provided between the light-transmitting part **21** and the housing **1**, and the elastic connection structure **23** includes at least two elastic connection arms **231** provided on opposite sides of the light-transmitting part **21**; the inner surface of the first wall **11** is provided with two heat-melting posts **114**, each thermally fused to its corresponding elastic connection arm **231**," since thermal fusion temperature between the elastic connection arms **231** and the heat-melting posts **114** is relatively high, the heat-melting posts **114** are positioned away from the limiting post **13** and the first threaded post **14** to prevent damage to them.

[0202] Additionally, based on the above embodiments where "the power supply unit **7** includes a USB module **73** provided on the PCB board **6**; the housing **1** is provided with a USB socket **12** corresponding to the USB module **73** for inserting a USB charging cable to electrically connect with the USB module **73**" and "the housing **1** is provided with at least one limiting post **13** protruding from a side wall corresponding to the PCB board **6**, the PCB board **6** is provided with a limiting hole **61** corresponding to the limiting post **13**, and the limiting hole **61** is adapted to the limiting post **13** for insertion of the limiting post **13**," the microwave sensing apparatus **100** is powered via USB charging. When inserting or removing the USB charging cable with an operating force, this force acts on the USB module **73** and then on the PCB board **6**, causing the PCB board **6** to shake and affecting the installation stability of the electronic components on the PCB board **6**. Therefore, referring to FIGS. **33** and **34**, in some embodiments of the present invention, corresponding to the force direction on the PCB board **6**, at least two limiting posts **13** are provided, and correspond to two edge portions of the PCB board **6** arranged in opposite directions, with one of the limiting posts **13** adjacent to the USB socket **12** and the other directly opposite to the USB socket **12**. The force exerted by the limiting posts **13** on the PCB board **6** can counteract the operating force, making the installation of the PCB board **6** more stable, preventing shaking, and improving the installation stability of the electronic components, ensuring the performance of the microwave sensing apparatus **100**.

[0203] Of course, to further improve the installation stability of the PCB board **6**, positioning members may be provided. Specifically, in some embodiments of the present invention, the housing **1** is provided with multiple positioning assemblies spaced along the circumference of the PCB board **6**. Each positioning assembly includes a first positioning protrusion and a second positioning protrusion spaced along the thickness direction of the PCB board **6**, with a spacing greater than or equal to the thickness of the PCB board **6**, so that the positioning assembly can snap onto the PCB board **6** to fix its installation position and improve its installation stability. Further, the first positioning protrusion and the second positioning protrusion are arranged sequentially along the installation direction of the PCB board **6**, and the end surface of the first positioning protrusion away from the second positioning protrusion is inclined towards the second positioning protrusion, facilitating the installation and disassembly of the PCB board **6** and improving efficiency. Still further, based on the above embodiment where "the housing **1** is provided with at least one first threaded post **14** protruding from a side wall corresponding to the PCB board **6**, the PCB board **6** is provided with a first screw **62** adapted to the first threaded post **14**, so that the PCB board **6** is threadedly connected to the housing **1** via the first threaded post **14** and the first screw **62**," the second positioning protrusion includes the first threaded post **14**, simplifying the structure and reducing production costs.

[0204] Of course, to further improve the installation stability of the PCB board **6**, pressing posts **18** may be provided. Specifically, at least one side wall of the housing **1** corresponding to the PCB board **6** is provided with the pressing posts **18** to act on the PCB board **6** along its thickness direction, limiting the movement of the PCB board **6** in the thickness direction.

[0205] More specifically, the above three technical features may be set separately or simultaneously. Referring to FIGS. **24**, **25**, **33**, **34**, **37**, and **38**, in some embodiments of the present invention, the above three technical features are set simultaneously. The housing **1** is cylindrical, with a first wall **11** (top wall), a third wall **16** (bottom wall) opposite to the first wall **11**, and a peripheral side wall connecting the first wall **11** and the third wall **16**. The peripheral side wall and the first wall **11** together form an upper shell with a receiving cavity, and the third wall **16** is detachably covered on the open end of the receiving cavity. The life presence sensor corresponds to the first wall **11**. The first threaded post **14** and the limiting post **13** are provided on the first wall **11**, the pressing post **18** is provided on the third wall **16**, and the positioning assembly and the USB socket **12** are provided on the peripheral side wall. Further, the first wall **11** is provided with a plurality of second threaded posts, and the third wall **16** is provided with second screws corresponding to the second threaded posts for insertion. The upper shell and the third wall **16** are threadedly connected by the second threaded posts and the second screws. Still further, the pressing post **18** is hollow and corresponds to the second screw. The end surface area of the pressing post **18** is larger than that of the second threaded post, so that when the third wall **16** is covered on the upper shell, the pressing post **18** sleeves the periphery of the second threaded post and presses against the PCB board **6**. This arrangement of structures makes the housing **1** structurally concise.

[0206] Specifically, to facilitate quick and correct installation of the PCB board **6**, the first wall **11** and the PCB board **6** are provided with installation marks **8**, respectively. This allows quick identification of the installation direction of the PCB board **6** by the installation marks **8**, ensuring that after installation, the electronic components on the PCB board **6** correspond to the optical transceiver **2**. More specifically, in some embodiments of the present invention, the installation mark **8** is set as an arrow pattern, clearly indicating the installation direction for quick and correct assembly.

[0207] Specifically, to facilitate the installation of the PCB board **6**, referring to FIG. **35**, in some embodiments of the present invention, opposite end surfaces of the PCB board **6** are partially recessed to form gripping grooves **63**, allowing users to insert their fingers into the gripping grooves **63** to grip the PCB board **6** for installation or disassembly, making the operation simple, convenient, and quick.

[0208] It should be noted that in the present invention, the above two technical features may be set separately or simultaneously. Specifically, referring to FIG. **35**, in some embodiments of the present invention, the above two technical features are set simultaneously, i.e., the first wall **11** and the PCB board **6** are provided with installation marks **8**, and the opposite end surfaces of the PCB board **6** are partially recessed to form gripping grooves **63**, enabling quick assembly of the PCB board **6** and greatly improving assembly efficiency.

[0209] Further, the third wall **16**, i.e., the bottom wall of the housing **1**, must be correctly installed when covering the upper shell of the housing **1**. For example, in the above embodiment where "the power supply unit **7** includes a power board **71**, which is electrically connected to the PCB board **6** via PIN pins. The power board **71** is provided with a wiring port **72**, which is electrically connected to an external wire by a second through hole **161** opened in the housing **1**", the second through hole **161** is provided on the third wall **16** and is rectangular. If the third wall **16** is installed in the wrong direction, the second through hole **161** will not match the wiring port **72**, affecting the operation of the wiring port **72** with the external power cord, or even causing the third wall **16** to fail to cover the upper shell, requiring re-installation. To address this, fool-proof posts may be added to facilitate identification of the installation direction. More specifically, a first connecting plate is connected between the second threaded post and the peripheral side wall, and the end surface of the first connecting plate is lower than that of the second threaded post. At the same time, the first wall **11** is also provided with a first fool-proof post, and a second connecting plate is connected between the first fool-proof post and the peripheral side wall. The end surface of the second connecting plate is flush with that of the first fool-proof post. The third wall **16** is provided with a second fool-proof post corresponding to the first fool-proof post, and the end surface area of the second fool-proof post is larger than that of the first fool-proof post. The second fool-proof post is recessed to form an avoidance groove at the position corresponding to the second connecting plate, so that when the third wall **16** is covered on the upper shell, the second fool-proof post sleeves the periphery of the second threaded post, and the second connecting plate engages with the avoidance groove. This arrangement limits the installation direction of the third wall **16**, allowing identification of the correct installation direction by the positions of the first and second fool-proof posts, facilitating the assembly of the third wall **16** and the upper shell.

[0210] Of course, the installation direction may also be indicated by installation marks **8**. Since identifying the position of the installation marks **8** is simpler than identifying the positions of the first and second fool-proof posts, the assembly by the installation marks **8** is quicker than by the fool-proof posts. Specifically, in some embodiments of the present invention, the third wall **16** is also provided with installation marks **8**. If the housing **1** is provided with the power board **71**, the power board **71** is also provided with installation arrow marks, facilitating quick and correct installation.

[0211] Further, referring to FIG. **25**, in some embodiments of the present invention, the PCB board **6** is provided with an avoidance hole **64** corresponding to the antenna of the communication module **5**, reducing interference with antenna signal transmission and ensuring normal signal reception and transmission by the communication module **5**.

[0212] Specifically, in the present invention, the housing **1** has a second wall **15**, and the sensing module **31** corresponds to and is parallel to the second wall **15**. The second wall **15** is any wall of the housing **1**, improving the sensing effect of the sensing module **31**. More specifically, in some embodiments of the present invention, the second wall **15** and the first wall **11** are the same wall of the housing **1**.

[0213] More specifically, one end of the sensing module **31** is electrically connected to the PCB board **6** by PIN pins, and the other end is provided with a support member corresponding to the PIN pins to ensure that the sensing module **31** is parallel to the second wall **15**. It should be noted that in the present invention, the form of the support member is not limited, and can be columnar, or plate, etc. At the same time, the manner in which the support member is connected to the PCB board **6** and the sensing module **31** is also not limited, and can be threaded, snap-fitted, etc. More specifically, in some embodiments of the present invention, the support member is bonded to the sensing module **31** and the PCB board **6**, respectively, with simple operation.

[0214] Specifically, in some embodiments of the present invention, the sensing module **31** is a radar module **311**. By transmitting detection waves to the actual sensing region and receiving echoes fed back by moving objects in the target sensing region within the actual sensing region, human body targets in a set space can be detected. Combined with radar signal processing and precise human body sensing algorithms, high-sensitivity human presence detection is achieved, capable of identifying both moving and stationary human bodies, and calculating auxiliary information such as target distance. Specifically, the radar module **311** can detect and identify human bodies in motion, micro-motion, standing, sitting, or lying positions, enabling the microwave sensing apparatus **100** to sense human presence in its space. The sensing results can be sent out for automatic lighting control, and can also automatically turn off controlled devices like TVs and air conditioners when prolonged absence is detected, ensuring both energy efficiency and

safety.
[0215] Specifically, since the radar module **311** is housed within the housing **1**, detection waves pass through the housing **1** during transmission and reception, resulting in losses. Therefore, certain performance parameters of the housing **1** (including material, structural shape, thickness, uniformity, and distance from the radar module **311**, etc.) will affect the performance of the radar module **311** (such as power loss, antenna gain, sensing range, etc.). Therefore, in the present invention, certain performance parameters of the housing **1** are specifically designed. Specifically, different materials of the housing **1** result in varying detection wave losses for the radar module **311**, thereby affecting its sensing distance. Thus, the housing **1** must exhibit good wave-transmitting properties at the operating center frequency of the radar module **311** and cannot contain metal or materials that shield detection waves. Generally, the higher the relative dielectric constant of the housing material, the greater the detection wave loss and the shorter the sensing distance. Accordingly, in some embodiments of the present invention, the relative dielectric constant of the housing **1** material is less than or equal to 3.0. More specifically, in some embodiments of the present invention, the housing **1** material is ABS plastic, which has a relative dielectric constant of 2.5, resulting in minimal detection wave loss and low production costs.
[0216] Specifically, in the present invention, based on the embodiment where “the housing has a second wall, the radar module corresponds to the second wall, and the second wall is any wall of the housing,” the wavelength of the detection wave from the radar module **311** in air is set as λ.sub.1, the distance from the radar module **311** to the second wall **15** is set as H, and H≥n×0.5λ.sub.1, where n is a positive integer. Preferably, n is 2 or 3, with an error margin of ±1.2 mm. Specifically, in the present invention, the thickness of the second wall **15** is uniformly set. The wavelength of the detection wave from the radar module **311** in the housing **1** is set as λ.sub.2, and the thickness of the portion of the second wall **15** corresponding to the sensing region of the radar module **311** is set as D, where D≤λ.sub.2. Further, 0.1×λ.sub.2≤D≤0.7×λ.sub.2, preferably D=0.125×λ.sub.2 or D=0.5×λ.sub.2. The thickness of the second wall **15** corresponding to the radar module **311** sensing region is further reduced to reduce the loss of the detection wave.
[0217] It should be noted that the portion of the second wall **15** corresponding to the sensing region of the radar module **311** may be the entire second wall **15** or only a part of it.
[0218] Furthermore, if the part of the second wall **15** corresponding to the sensing region of the radar module **311** is only a part of the part of the second wall **15** and the thickness of the part of the second wall **15** corresponding to the sensing region of the radar module **311** is too thin, the strength of the second wall **15** will be affected in a case that the thickness of all the parts of the second wall **15** is the same as the thickness of the part of the second wall **15** corresponding to the sensing region of the radar module **311**. In this regard, the thickness of the part of the second wall **15** corresponding to the sensing region of the radar module **311** can be designed to increase, so that the thickness of the second wall **15** is set as D.sub.2, D2≥D, thereby ensuring the strength of the second wall **15**, namely, the housing **1**, and improving the practicality. Meanwhile, the overall thickness of the second wall **15** is uniform, and the aesthetics is high.
[0219] In addition, the structural design of the radar module **311** itself affects its performance, including power consumption, sensing range, sensing accuracy, and production cost.
[0220] Specifically, referring to FIG. **26**, the radar module **311** includes a dielectric board **3111**, a radar chip **3112**, a transmitting antenna **3113**, and a receiving antenna **3114**. The radar chip **3112**, the transmitting antenna **3113**, and the receiving antenna **3114** are mounted on the signal radiation surface of the dielectric board **3111**. The radar chip **3112** is communicatively connected to the communication module **5**. The transmitting antenna **3113** is electrically connected to the radar chip **3112** via a first feed line **3115**, and the receiving antenna **3114** is electrically connected to the radar chip **3112** via a second feed line **3116**. It should be noted that, to miniaturize the microwave sensing apparatus **100**, the radar module **311** is also designed for compactness. Specifically, the dielectric board **3111** is measured to 7 mm×35 mm. Based on the specific structure of the radar

module **311**, the principle is as follows. The radar chip **3112** emits detection waves by the transmitting antenna **3113**, forming an actual sensing region covered by the detection waves. The receiving antenna **3114** receives echoes from moving objects in the target sensing region within the actual sensing region. The radar chip **3112** processes the echoes into sensing data and transmits it to the communication module **5**, which then processes the sensing data according to preset procedures to generate the sensing result.

[0221] Further, referring to FIG. **26**, the transmitting antenna **3113** and the receiving antenna **3114** are positioned on both sides of the radar chip **3112**. Additionally, the distance from the transmitting antenna **3113** to the radar chip **3112** is less than that from the receiving antenna **3114** to the radar chip **3112**. More specifically, in some embodiments, the distance from the transmitting antenna **3113** to the radar chip **3112** is 4.66 mm, and the distance from the receiving antenna **3114** to the radar chip **3112** is 12.71 mm.

[0222] Further, referring to FIG. **26**, the first feed line **3115** is less than the second feed line **3116**, avoiding winding structures in the first feed line **3115** to minimize radiation from bends, thereby reducing its impact on the antenna radiation pattern and enhancing detection wave transmission quality. More specifically, the lengths of the first feed line **3115** and the second feed line **3116** are determined based on their distances to the transceiving antennas and frequency parameters. Based on the above embodiment where "the distance from the transmitting antenna **3113** to the radar chip **3112** is 4.66 mm, and the distance from the receiving antenna **3114** to the radar chip **3112** is 12.71 mm.", the length of the first feed line **3115** is set to 7.81 mm, and the length of the second feed line **3116** is set to 16.38 mm.

[0223] Specifically, by selecting the first feed line **3115** and the second feed line **3116** with different waveguide wavelengths, the first feed line **3115** can avoid winding structures while ensuring synchronized transmission of the receiving antenna **3114** and the transmitting antenna. That is, the waveguide wavelength of the first feed line **3115** is less than that of the second feed line **3116**, so that the detection waves transmitted by the first feed line **3115** and the second feed line **3116** can simultaneously reach their respective connected antennas.

[0224] It should also be noted that, the electrical connection methods between the transmitting antenna **3113** and the first feed line **3115**, and between the receiving antenna **3114** and the second feed line **3116**, are not limited. Specifically, referring to FIG. **26**, in some embodiments of the present invention, the transmitting antenna **3113** is connected to the first feed line **3115** with an embedded feed, and the receiving antenna **3114** is connected to the second feed line **3116** with an embedded feed such that the embedded feed is located near the center of the antenna and the input impedance is reduced as compared to other electrical connections (e.g., edge feeds, etc.). The forms of the transmitting antenna **3113** and the receiving antenna **3114** are not restricted. Referring to FIG. **26**, in some embodiments of the present invention, each of the transmitting antenna **3113** and the receiving antenna **3114** is a rectangular microstrip patch antenna, and the beam is narrowed, i.e., a multi-antenna integrated design is advantageous for the millimeter-wave radar sensor integrated miniaturization design. More specifically, the area of the transmitting antenna **3113** is larger than that of the receiving antenna **3114**. In some embodiments, the transmitting antenna **3113** is measured to 3.63 mm×2.89 mm, and the receiving antenna **3114** is measured to 3.33 mm×2.81 mm.

[0225] Specifically, in the present invention, the radar module **311** has a sensing angle range of 0-120°. Its wide sensing range can at least meet the use of general working and living space, and its practicability is high.

[0226] Specifically, in the present invention, the sensing distance of the radar module **311** ranges from 0.75 m to 6.0 m, covering a wide range and meeting the needs of general living and working spaces, offering high practicality. It should be noted that the above two technical features may be set separately or simultaneously. Specifically, in some embodiments of the present invention, the above two technical features are set simultaneously, i.e., the radar module **311** has a sensing angle range of 0-120°, and the sensing distance of the radar module **311** ranges from 0.75 m to 6.0 m. More specifically, within the sensing angle range of 0-120°, when a person is sitting still, the sensing distance of the radar module **311** is at least 4 meters; when a person is standing, the sensing distance is at least 4.5 meters; and when a person is moving, the sensing distance is at least 5 meters.

[0227] Referring to FIGS. **22**, **23**, **27-36**, and **39-44**, in some embodiments, to facilitate secure mounting of the housing **1** to a mounting surface, the microwave sensing apparatus **100** further includes a mounting bracket **9** connected to the housing **1** for secure mounting of the housing **1** to a mounting surface.

[0228] The mounting bracket **9** is connected to the housing **1**, and is configured to drive the housing **1** to change angles in at least one degree of freedom so as to change the actual sensing region of the sensing module **31**, thereby achieving flexible mounting of the microwave sensing apparatus **100**, facilitating a user to adjust the actual sensing region of the microwave sensing apparatus **100** according to the actual situation of the mounting space and usage requirements, and further enabling the target sensing region formed on the basis of a certain sub-sensing region in the actual sensing region to have a larger adjustable range on the basis of flexible adjustment of the actual sensing region. Thus, it enables the microwave sensing apparatus **100** to be applicable to different use scenarios, and improve the practicality of the microwave sensing apparatus **100**.

[0229] Still further, in some embodiments of the present invention, the mounting bracket **9** is configured to change angles in at least two degrees of freedom and drive the housing **1** to move for adjusting the actual sensing region of the sensing module **31**. By changing angles in two degrees of freedom, the adjustable angle range of the actual sensing region of the sensing module **31** is increased, making it suitable for more installation environments and enabling adjustment of the actual sensing region of the sensing module **31** to an optimal region.

[0230] More specifically, referring to FIGS. **22**, **23**, **24**, and **27-34**, the mounting bracket **9** includes a base **91** for fixed mounting on the mounting surface, a first movable member **92**, and a second movable member **93**. The first movable member **92** is rotatably connected to the base **91**. The second movable member **93** is rotatably connected to the first movable member **92** and is rotatably connected to the base **91** via the first movable member **92**, enabling the second movable member **93** to change angles in at least two degrees of freedom relative to the base **91**. Herein, the second movable member **93** is connected to the housing **1** and configured to support the housing **1**, capable of driving the housing **1** to move under a second operating force, and to fixedly support the housing **1** when the second operating force is removed. That is, by rotating the second movable member **93**, the position of the second movable member **93** can be changed in one degree of freedom relative to the base **91** to adjust the actual sensing region of the microwave sensing apparatus **100**. By rotating the first movable member **92**, the position of the second movable member **93** can be changed in another degree of freedom relative to the base **91** to adjust the actual sensing region of the microwave sensing apparatus **100**. Additionally, by first rotating one of the first movable member **92** and the second movable member **93** and then rotating the other, the position-changeable range of the second movable member **93** can be increased, thereby expanding the adjustable range of the actual sensing region of the microwave sensing apparatus **100** and improving practicality.

[0231] It should be noted that the rotatable connection manner between the first movable member **92** and the second movable member **93** is not limited. In some embodiments of the present invention, the first movable member **92** and the second movable member **93** are pivotally connected by a first rotating shaft **24**, enabling the second movable member **93** to change angles relative to the base **91** in a first degree of freedom. The first rotation shaft **24** extends in a direction parallel to the base **91**. The first movable member **92** has a first contact surface **921**, and the second movable member **93** has a second contact surface **931**. The mounting bracket **9** has a first state and a second state. In the first state, the first contact surface **921** and the second contact surface **931** are at least partially in contact or at least partially overlapped. In the second state, an angle is formed between the first contact surface **921** and the second contact surface **931**. It can be understood that the first contact surface **921** is a side of the first movable member **92** facing towards the second movable member **93**, and the second contact surface **931** is a side of the second movable member **93** facing towards the first movable member **92**. That is, the first contact surface **921** and the second contact surface **931** are either fully or partially in contact. Thus, the first state can be understood as the state where the angle between the first movable member **92** and the second movable member **93** is 0°. Specifically, referring to FIG. **30**, in some embodiments of the present invention, in the first state, the first contact surface **921** and the second contact surface **931** are fully in contact. The first contact surface **921** and the second contact surface **931** being at least partially overlapped means they are either fully or partially overlapped. That is, when one of the first contact surface **921** and the second contact surface **931** has a corresponding recess to accommodate the other, enabling full overlap when in the first state, or when one of the first contact surface **921** and the second contact surface **931** has partially concave regions and the other has corresponding convex regions, enabling concave-convex fit of the first contact surface **921** and the second contact surface **931**, i.e., partial overlap when in the first state. This overlapping arrangement can conceal part of the structure of the mounting bracket **9**, reducing its overall volume and further decreasing the volume of the microwave sensing apparatus **100**, even allowing the mounting bracket **9** and the housing **1** to visually integrate, enhancing overall aesthetic appearance.

[0232] Further, referring to FIG. **30**, in some embodiments of the present invention, the first rotation shaft **24** is provided at an edge of the first movable member **92**, which can reduce interference between the second movable member **93** and the first movable member **92** during pivotal movement of the second movable member **93** relative to the first movable member **92**, thereby facilitating the pivotal movement of the second movable member.

[0233] Further, referring to FIGS. **23** and **27-32**, a first connection portion **95** and a second connection portion **96** are provided between the first movable member **92** and the second movable member **93**. The first connection portion **95** is formed at an edge portion of one of the first movable member **92** and the second movable member **93** and is concavely formed with a mounting groove **951**. The mounting groove **951** has opposite side walls each penetratingly provided with a first rotation hole. The second connection portion **96** protrudes from the other of the first movable member **92** and the second movable member **93**, is adapted to the mounting groove **951**, and is penetratingly provided with a second rotation hole corresponding to the first rotation hole. The first rotation shaft **24** is inserted through the first rotation hole and the second rotation hole, so that the first connection portion **95** and the second connection portion **96** are pivotally connected, thereby enabling relative pivotal movement between the first movable member **92** and the second movable member **93**, and improving rotational stability between the first movable member **92** and the second movable member **93**.

[0234] It should be noted that the positions of the first connection portion **95** and the second connection portion **96** are not limited. Specifically, referring to FIGS. **23** and **27-32**, in some embodiments of the present invention, the first connection portion **95** is formed on the first movable member **92**, meaning the mounting groove **951** is formed at an edge portion of the first movable member **92**, and the second connection portion **96** protrudes from the second movable member **93**. Referring to FIGS. **23** and **27-32**, in some embodiments of the present invention, the first connection portion **95** is formed on the second movable member **93**, meaning the mounting groove **951** is formed at an edge portion of the second movable member **93**, and the second connection portion **96** protrudes from the first movable member **92**.

[0235] Further, the peripheral portion of the hole side wall where the first rotation hole is formed on the first connection portion **95** is curved, enabling the second movable member **93** to change angles relative to the base **91** in the first degree of freedom within a range of 0° to 90°, further reducing interference between the second movable member **93** and the first movable member **92** during pivotal movement, expanding the angle-changeable range of the second movable member

**93** in the first degree of freedom, and thereby increasing the detectable range of the sensing module **31**.

[0236] Further, referring to FIGS. **23** and **27-32**, the first movable member **92** or the second movable member **93** provided with the second connection portion **96** is concavely provided with an avoidance portion **97** corresponding to the first connection portion **95** to avoid the first connection portion **95** during rotation, enabling the second movable member **93** to change angles relative to the base **91** in the first degree of freedom within a range of 0° to 180°. The avoidance portion **97** further reduces interference between the second movable member **93** and the first movable member **92** during pivotal movement, expanding the angle-changeable range of the second movable member **93** in the first degree of freedom.

[0237] Specifically, to enable the second movable member **93** to more stably support the housing **1** when the second operating force is removed, referring to FIG. **22**, a limiting member **942** is provided between each end of the second connection portion **96** and the corresponding side wall of the mounting groove **951**. After the second movable member **93** drives the housing **1** to move in response to the operating force, the limiting member **942** provides a limiting force between the first connection portion **95** and the second connection portion **96** to fixedly support the housing **1**. With this arrangement, when the second movable member **93** and the first movable member **92** perform pivotal movement, the friction (i.e., the limiting force) is generated between the first connection portion **95**, the second connection portion **96** and the limiting member **942**, thereby increasing the rotation damping of the second movable member **93** to fixedly support the housing **1**. More specifically, in some embodiments of the present invention, the limiting member **942** is an iron plate.

[0238] Specifically, to enable the second movable member **93** to fixedly support the housing **1** when the second operating force is removed, referring to FIG. **22**, the first rotation shaft **24** is a bolt **941**, which is fixedly inserted into the first connection portion **95** and the second connection portion **96** via a nut **943**. With this configuration, during pivotal movement of the second movable member **93** and the first movable member **92**, the friction is generated between the bolt **941** and the nut **943**, increasing the rotation damping of the second movable member **93** to fixedly support the housing **1**. Meanwhile, the nut **943** can move relative to the bolt **941** under force, allowing adjustment of the friction between the first connection portion **95** and the second connection portion **96**. This not only enables fixed support of the housing **1**, but also allows the second movable member **93** to pivot under different magnitudes of the second operating force by adjusting the position of the nut **943**, facilitating user operation.

[0239] It should be noted that the above two technical features can be implemented separately or together. Specifically, referring to FIG. **22**, in some embodiments of the present invention, both features are implemented simultaneously: a limiting member **942** is provided between each end of the second connection portion **96** and the corresponding side wall of the mounting groove **951**. After the second movable member **93** drives the housing **1** to move in response to the operating force, the limiting member **942** provides a limiting force between the first connection portion **95** and the second connection portion **96** to fixedly support the housing **1**. The first rotation shaft **24** is a bolt **941** fixedly inserted into the first connection portion **95** and the second connection portion **96** via a nut **943**. This means the rotation damping of the second movable member **93** is increased by both the limiting member **942** and the bolt **941**, enabling the housing **1** to be more stably supported by the second movable member **93**.

[0240] Specifically, in other embodiments of the present invention, referring to FIGS. **33** and **34**, the first rotation shaft **24** extends in a direction perpendicular to the base **91**, and the first movable member **92** and the second movable member **93** are sleeved and/or magnetically connected, enabling the first movable member **92** to rotate about the first rotation shaft **24** relative to the second movable member **93**, with the first contact surface **921** and the second contact surface **931** in contact or at least partially overlapped. That is, whether the second movable member **93** and the first movable member **92** are in relative motion or stationary, the angle between them is 0°. Of course, in this case, the first rotation shaft **24** may be a solid body, and the first movable member **92** and the second movable member **93** may be sleeved via the first rotation shaft **24**. Additionally, the first movable member **92** and the second movable member **93** may be magnetically connected to enhance the connection stability and rotational stability between them. Alternatively, the first rotation shaft **24** may be an imaginary body, and the first movable member **92** and the second movable member **93** may be solely magnetically connected, allowing adjustment of their relative positions and thereby expanding the adjustable range of the actual sensing region of the sensing module **31**.

[0241] In addition, the rotatable connection between the first movable member **92** and the base **91** is not limited. Specifically, the first movable member **92** is sleeved or magnetically connected to the base **91** and can rotate relative to the base **91** about a second rotation shaft extending in a direction perpendicular to the base **91**. Of course, the second rotation shaft may be a solid body or an imaginary body.

[0242] Further, the first movable member **92** can rotate relative to the base **91** about the second rotation shaft within an angle range of 0° to 360°, enabling the first movable member **92** to perform continuous circumferential rotation or reciprocating circumferential rotation relative to the base **91**, thereby expanding the adjustable range of the actual sensing region of the microwave sensing apparatus **100**.

[0243] Specifically, referring to FIGS. **22**, **23**, **27-29**, and **33**, in some embodiments of the present invention, the first movable member **92** includes a bottom cover **923** and a surface cover **924**, with the bottom cover **923** having an accommodation hole **9231** therethrough. The surface cover **924** is detachably mounted on the bottom cover **923**. The base **91** is inserted into the bottom cover **923** through the accommodation hole **9231** to be sleeved within the first movable member **92** and can rotate relative to the bottom cover **923** about the second rotation shaft, thereby achieving rotatable connection between the first movable member **92** and the base **91**, allowing 360° rotation relative to the base **91** about the second rotation shaft, and facilitating disassembly and assembly.

[0244] Further, since the contact area between the base **91** and the surface cover **924** is large, when the first movable member **92** rotates relative to the base **91**, the friction generated between them is also large, meaning that the rotation damping of the first movable member **92** is large, affecting the rotation effect. In this regard, referring to FIG. **22**, in some embodiments of the present invention, at least one resistance rib **911** protrudes from the end face of the base **91** facing towards the first movable member **92**. When the surface cover **924** is mounted on the bottom cover **923**, the resistance rib **911** abuts against the surface cover **924**, ensuring only the resistance rib **911** contacts the surface cover **924** with a small contact area, thereby reducing friction between them during relative rotation of the first movable member **92** and the base **91**, facilitating rotation.

[0245] It should be noted that in the present invention, the connection method between the bottom cover **923** and the surface cover **924** is not limited, and may include threaded connection, snap connection, plug connection, etc. Specifically, in some embodiments of the present invention, the bottom cover **923** and the surface cover **924** are threadedly connected, making assembly and disassembly simple and convenient with low production costs. Specifically, in some embodiments of the present invention, a silicone pad **925** is provided on a side of the bottom cover **923** away from the surface cover **924**, and the silicone pad **925** is provided with an avoidance through hole **9251** corresponding to the base **91**, enabling the bottom cover **923** to rotate relative to the base **91**. The silicone pad **925** increases the friction between the bottom cover **923** and the mounting surface, i.e., increases the rotation damping between the first movable member **92** and the mounting surface, facilitating the mounting bracket **9** to more stably support and fix the housing **1** when the second operating force is removed. Meanwhile, based on the aforementioned embodiment where "the bottom cover **923** is threadedly connected to the surface cover **924**," when the bottom cover **923** is provided with screws and the surface cover **924** is provided with screw posts, the silicone

pad **925** can correspond to the screws to conceal them, thereby improving the aesthetics of the bottom cover **923** and consequently enhancing the overall aesthetic appearance of the mounting bracket **9**. It should be noted that in the present invention, the above two technical features can be implemented separately or simultaneously. Specifically, referring to FIG. **22**, in some embodiments of the present invention, both technical features are implemented simultaneously: the bottom cover **923** is threadedly connected to the surface cover **924**, and a silicone pad **925** with an avoidance through hole **9251** corresponding to the base **91** is provided on a side of the bottom cover **923** away from the surface cover **924**. This facilitates assembly and disassembly of the first movable member **92** and the base **91**, reduces production costs, increases rotation damping between the first movable member **92** and the mounting surface, ensures the mounting bracket **9** can more stably support the housing **1** when the second operating force is removed, and improves the overall aesthetic appearance of the mounting bracket **9**.
[0246] It should also be noted that the connection method between the bottom cover **923** and the silicone pad **925** is not limited and may include snap-fit, adhesive bonding, threaded connection, etc.
[0247] Additionally, in other embodiments of the present invention, the second rotation shaft extends in a direction parallel to the base **91**, and the first movable member **92** is pivotally connected to the base **91** by the second rotation shaft.
[0248] In the present invention, the assembly method between the mounting bracket **9** and the housing **1** is not limited. Specifically, referring to FIG. **23**, in some embodiments of the present invention, the housing **1** has an opening, and the second movable member **93** covers the opening end, thereby reducing the overall thickness of the microwave sensing apparatus **100**.
[0249] Further, the connection method between the housing **1** and the second movable member **93** is not limited and may include fixed connection (e.g., integral molding) or detachable connection (e.g., threaded connection, snap-fit, etc.). Specifically, referring to FIGS. **22** and **23**, in some embodiments of the present invention, multiple screws are included, spaced circumferentially around the housing **1** and sequentially penetrating the housing **1** and the second movable member **93**, making assembly convenient and production costs low.
[0250] Further, since the screws are metal components and affect the signal strength of the antenna of the communication module **5**, the distance from each screw to the antenna must be defined. The distance from each screw to the antenna of the communication module **5** is set as L.sub.1, where L.sub.1≥2.3 mm, ensuring normal signal transmission.
[0251] Specifically, the opening end face of the housing **1** is recessed to form a seam allowance groove, and the periphery of the side of the second movable member **93** facing towards the housing **1** has a mating protrusion, so that when the second movable member **93** covers the opening end of the housing **1**, the mating protrusion fits and abuts against the bottom wall of the seam allowance groove, enabling faster assembly of the housing **1** and the second movable member **93**.
[0252] Specifically, referring to FIG. **23**, in other embodiments of the present invention, the housing **1** has a third wall **16**, which is a side wall connected to or opposite the first wall **11**. The second movable member **93** is detachably connected to the third wall **16**, facilitating assembly of the mounting bracket **9** and the housing **1**.
[0253] Further, the second movable member **93** fits or at least partially overlaps with the third wall **16**, reducing the overall thickness of the microwave sensing apparatus **100**. More specifically, the surface area of the second movable member **93** is smaller than that of the third wall **16**, and the second movable member **93** is fully overlapped with the third wall **16**. Thus, from certain viewing angles, the housing **1** obscures the mounting bracket **9**, improving the overall aesthetic appearance of the microwave sensing apparatus **100**.
[0254] Specifically, the phase position arrangement between the second movable member **93** and the housing **1** is not limited. Referring to FIGS. **23**, **33**, and **34**, in some embodiments of the present invention, the center of the second movable member **93** corresponds to the center of the third wall

**16**, enhancing the overall stability of the microwave sensing apparatus **100** during installation. More specifically, when both the third wall **16** and the second movable member **93** are circular, the third wall **16** and the second movable member **93** are concentrically provided.
[0255] Specifically, in other embodiments of the present invention, the area of the second movable member **93** is smaller than that of the third wall **16**, and part of the edge of the second movable member **93** corresponds to the edge of the third wall **16**. More specifically, when both the third wall **16** and the second movable member **93** are circular, the third wall **16** is inscribed with the second movable member **93**.
[0256] Specifically, the detachable connection method between the third wall **16** and the second movable member **93** is not limited and may include threaded connection, snap-fit, etc. Specifically, referring to FIGS. **33** and **34**, in some embodiments of the present invention, the second movable member **93** is magnetically connected to the third wall **16**, which allows for simple and quick disassembly and assembly. More specifically, when the second movable member **93** is magnetically connected to the third wall **16**, their relative positions can be adjusted in real time. The center of the second movable member **93** may correspond to the center of the third wall **16**, or part of the edge of the second movable member **93** may correspond to the edge of the third wall **16**, as long as at least part of the magnetic member on the second movable member **93** can magnetically attract at least part of the magnetic member on the third wall **16**. This makes the installation of the housing **1** more flexible, further expanding the adjustable range of the actual sensing region of the sensing module **31**, making it applicable to more scenarios and improving the practicality of the microwave sensing apparatus **100**.
[0257] In the present invention, the installation method of the mounting bracket **9** is not limited and may include magnetic connection, snap-fit, threaded connection, adhesive bonding, etc. More specifically, in some embodiments of the present invention, the mounting bracket **9** is magnetically connected to the mounting surface. Specifically, the base **91** is provided with a first magnetic member **912** for magnetic connection with a second magnetic member provided on the mounting surface, enabling convenient, quick and flexible installation with a wide angle adjustment range for the mounting bracket **9**. More specifically, the side of the base **91** facing towards the housing **1** is provided with a mounting groove **951** containing the first magnetic member **912**. In other embodiments of the present invention, the mounting bracket **9** is adhesively bonded to the mounting surface. Referring to FIGS. **33** and **34**, the side of the base **91** opposite to the housing **1** has an adhesive member for bonding to the mounting surface, enabling convenient and stable installation.
[0258] It should be noted that the above two technical features can be implemented separately or simultaneously. Specifically, in some embodiments of the present invention, both features are implemented simultaneously: the base **91** has a first magnetic member **912** for magnetic attraction with a second magnetic member on the mounting surface, and the side of the base **91** opposite to the housing **1** has an adhesive member for bonding to the mounting surface. This allows the mounting bracket **9** to be installed on the mounting surface either magnetically or adhesively. That is, it may be attached to the mounting surface on which the magnet member is provided or to the mounting surface on which the magnet member is not provided, so as to expand its installation range. Different installation methods can be chosen for different mounting surfaces, improving practicality. Further, when the mounting bracket **9** adopts magnetic connection, the distance between the first magnetic member **912** and the antenna of the communication module **5** must be limited to reduce the impact of the first magnetic member **912** on antenna signal strength. When the first movable member **92** and the second movable member **93** are in contact or overlapped, the first magnetic member **912** is closest to the antenna. Therefore, it is sufficient to limit the distance L.sub.2 between the first magnetic member **912** and the antenna of the communication module **5** when the first movable member **92** and the second movable member **93** are in contact or overlapped. Based on multiple tests, L.sub.2≥3.6 mm, which can reduce the impact of the first

magnetic member **912** on antenna signal strength, ensuring normal signal transmission and reception by the communication module **5**. More specifically, the distance between the first magnetic member **912** and the antenna of the communication module **5** is related to factors such as the antenna's position within the housing **1** and the thickness of the second movable member **93**.

[0259] Of course, in other embodiments of the present invention, referring to FIGS. **35**, **36**, and **39-44**, the housing **1** rotates relative to the mounting surface in one degree of freedom. Specifically, the mounting bracket **9** is rotatably connected to the housing **1**, allowing the housing **1** to rotate relative to the mounting bracket **9** in one degree of freedom under a third operating force, thereby adjusting the actual sensing region of the sensing module **31**.

[0260] More specifically, in some embodiments of the present invention, referring to FIGS. **35**, **36**, and **39-44**, the mounting bracket includes a movable sleeve **98** sleeved on the outer periphery of the housing **1** and rotatably connected to the housing **1** via a third rotation shaft **981**. A movement gap exists between the inner side wall of the movable sleeve **98** and the housing **1** to allow rotation of the housing **1**. That is, the housing **1** can rotate about the third rotation shaft **981** relative to the movable sleeve **98**, enabling adjustment of the actual sensing region of the sensing module **31**, with a simple structure. When the third operating force is removed, the friction between the third rotation shaft **981** and the housing **1** serves to support and fix the housing **1**. More specifically, in some embodiments of the present invention, the third rotation shaft **981** is a screw.

[0261] It should be noted that in the present invention, one or two third rotation shafts **981** may be provided. Specifically, in some embodiments of the present invention, two third rotation shafts **981** are provided, which are inserted into opposite sides of the movable sleeve **98**. The housing **1** is correspondingly provided with two rotation holes, each for receiving its corresponding third rotation shaft **981**, so that the housing **1** and the movable sleeve **98** are rotatably connected, and the assembly and disassembly of the movable sleeve **98** and the housing **1** are facilitated. Further, since the housing **1** is sleeved within the movable sleeve **98**, the rotational angle range of the housing **1** depends on the size of the movement gap. A larger rotational angle range requires a larger movement gap, but this also increases the volume of the movable sleeve **98**, i.e., the mounting bracket **9**. A larger mounting bracket **9** may appear disproportionate to the housing **1**, affecting aesthetic appearance and hindering the miniaturization design of the microwave sensing apparatus **100**. In some embodiments of the present invention, based on multiple tests, the rotational angle range of the housing **1** relative to the movable sleeve **98** is set to 0°-60°. More specifically, the housing **1** can rotate from its horizontal position to one side within a range of 0°-30°, balancing the adjustable range of the actual sensing region of the sensing module **31** with the overall aesthetic appearance of the microwave sensing apparatus **100**. More specifically, the movement gap is set to 1.5 mm.

[0262] Specifically, referring to FIGS. **35**, **36**, **39**, and **40**, in some embodiments of the present invention, the movable sleeve **98** has at least two spring clips **982** on its outer periphery which are arranged opposite to each other along the circumference of the movable sleeve **98**. The spring clips **982** can be forced closer to or farther from the movable sleeve **98** to engage with mounting holes **111** on the mounting surface. This arrangement allows the microwave sensing apparatus **100** to be installed on ceilings, specifically suspended ceilings. By applying force to the spring clips **982**, they rotate towards the movable sleeve **98** until they can be inserted through the mounting holes **111** into the ceiling. When the force is removed, the spring clips **982** elastically return to their initial positions, abutting against the inner wall of the ceiling, preventing the mounting bracket **9** from disengaging from the ceiling, ensuring stable installation with simple and convenient operation.

[0263] Specifically, referring to FIGS. **41-44**, in other embodiments of the present invention, the housing **1** has a second wall **15**, and the sensing module **31** corresponds to the second wall **15**. The mounting bracket includes a mounting box **99** with an opening, fixed to the mounting surface. The housing **1** is installed at the opening of the mounting box **99** via a buckle **17** and an engaging

annular wall **991**, with the second wall **15** spaced from the bottom wall of the mounting box **99**. One of the buckle **17** and the engaging annular wall **991** is provided on the housing **1**, and the other is provided on the side wall of the mounting box **99**. The buckle **17** and the engaging annular wall **991** engage with each other, and the buckle **17** can slide along the engaging annular wall **991**, allowing the housing **1** to rotate relative to the mounting box **99**. This arrangement enables the housing **1** to be installed via the mounting box **99** while adjusting the actual sensing region of the sensing module **31** through relative rotation. Additionally, the housing **1** and the mounting box **99** are detachably connected via the buckle **17** and the engaging annular wall **991**, facilitating simple and quick assembly and disassembly.
[0264] It should be noted that the connection between the mounting box **99** and the mounting surface is not limited and may include adhesive bonding, threaded connection, etc.
[0265] Further, when the microwave sensing apparatus **100** is powered by high voltage, based on the above embodiment where "the power supply unit **7** includes a power board **71**, which is electrically connected to the PCB board **6** via PIN pins; the power board **71** is provided with a wiring port **72**, which is electrically connected to an external power source by a second through hole **161** opened in the housing **1**," the inner side wall of the mounting box **99** has at least one wiring hole for routing, allowing external power cables to connect to the wiring port **72** sequentially through the wiring hole and the second through hole **161**.
[0266] The present invention also provides an optical transceiver **2**, referring to FIGS. **45** and **46**, suitable for a sensing device. The optical transceiver **2** includes a light-transmitting part **21** and a trigger part **22** on the light-transmitting part **21**. The light-transmitting part **21** allows light to pass through, enabling first-direction light emitted by the sensing device to pass through light-transmitting part **21** from inside to outside the sensing device and second-direction light incident through light-transmitting part **21** from outside to inside the sensing device. The trigger part **22** is configured to trigger the sensing device in response to a first operating force.
[0267] In the technical solution of the present invention, the optical transceiver **2** not only has light-transmitting properties but also includes the trigger part **22** for triggering, integrating light sensing, indication, and triggering functions into one component. When applied to the sensing device, it simplifies the device structure. Specifically, the sensing device includes a housing **1** and a sensing module **31**, a light sensing module **32**, a light-emitting module **33**, and a detection switch **4** inside the housing **1**. The light-transmitting part **21** corresponds to the light sensing module **32** and the light-emitting module **33**, enabling the light sensing module **32** to receive second-direction light passing through the light-transmitting part **21** for external light environment detection, and the light-emitting module **33** to emit first-direction light through the light-transmitting part **21** to indicate the real-time working state of the sensing device. The trigger part **22** corresponds to the detection switch **4**, enabling the detection switch **4** to be triggered and generate a trigger signal when the trigger part **22** is displaced under force, allowing the sensing device to switch its working state based on the trigger signal. Simultaneously, the optical transceiver **2** is provided on the housing **1**, reducing the number of openings in the housing **1** from three to one, improving the uniformity of the housing thickness, and minimizing adverse effects of openings on the sensing performance of the sensing device. Additionally, in dark environments, when the optical transceiver **2** is illuminated by first-direction light emitted by the sensing device, the users can clearly locate the optical transceiver **2** and accurately operate it to trigger the detection switch **4**, facilitating quick and real-time control of the sensing device.
[0268] It should be noted that the first direction and the second direction are opposite directions. The first direction is from the interior of the sensing device to the exterior of the sensing device, i.e., the outward direction, while the second direction is from the exterior of the sensing device to the interior of the housing **1**, i.e., the inward direction.
[0269] Further, referring to FIGS. **45** and **46**, the light-transmitting part **21** includes an indication region **211** and a light sensing region **212**. The indication region **211** allows light in the first

direction to pass through, while the light sensing region **212** allows light in the second direction to enter. In other words, the light-transmitting part **21** provides an indication function by the indication region **211** and a light sensing function by the light sensing region **212**.

[0270] It should be noted that the relative positions of the indication region **211** and light sensing region **212** are not limited. They may be separate or overlapping.

[0271] Further, referring to FIGS. **45** and **46**, in some embodiments of the present invention, the indication region **211** and the light sensing region **212** are overlapped. In other words, the overlapping region formed by the indication region **211** and the light sensing region **212** can both allow light to enter and exit, reducing the region occupied by the light-transmitting part **21** and simplifying the structure. This further reduces the opening region of the housing **1** and enhances the overall aesthetic appearance of the sensing device.

[0272] Specifically, referring to FIGS. **45** and **46**, the light-transmitting part **21** includes a light guide member **213**, as well as a first end surface **2131** and a second end surface **2132** provided at both ends of the light guide member **213**. The first end surface **2131** faces towards the exterior of the sensing device to form the indication region **211**, while the second end surface **2132** faces towards the interior of the sensing device and is close to the light sensing module **32** and light-emitting module **33** of the sensing device. Alternatively, the first end surface **2131** faces towards the exterior of the sensing device to form the light sensing region **212**, while the second end surface **2132** faces towards the interior of the sensing device and is close to the light sensing module **32** and light-emitting module **33** of the sensing device. The light guide member **213** has the function of collecting and guiding light, which is beneficial to reducing light loss during propagation and improving display brightness. Specifically, when the first end surface **2131** of the light guide member **213** faces outwards to form the light sensing region **212**, the light sensing region **212** has a light source gathering effect, facilitating the sensing device to receive and sense light in the second direction. When the first end surface **2131** of the light guide member **213** faces outwards to form the indication region **211**, and the second end surface **2132** faces inwards and is close to the light-emitting module **33**. The indication region **211** has a light source reflection effect, and light in the first direction is uniformly emitted through the indication region **211** with enhanced brightness, making the indication region **211** clearly visible with excellent prompting effect.

[0273] Note that the light guide member **213** may take various forms such as a light guide column or film, without limitation. More specifically, referring to FIGS. **45-46**, in some embodiments of the present invention, the light guide member **213** is a light guide column to further reduce light loss during propagation. It should also be noted that the number of light guide members **213** is not limited. Two light guide members **213** may be provided, where the first end surface **2131** of one forms the indication region **211**, with its second end surface **2132** close to the light-emitting module **33**, while the first end surface **2131** of the other one forms the light sensing region **212**, with its second end surface **2132** close to the light sensing module **32**. Alternatively, referring to FIGS. **45** and **46**, based on the above embodiment where “the indication region **211** and the light sensing region **212** are overlapped”, one light guide member **213** may be provided, where the first end surface **2131** of the light guide member **213** forms both the indication region **211** and the light sensing region **212**, and its second end surface **2132** faces outwards from the sensing device and is close to the light sensing module **32** and light-emitting module **33** of the sensing device, resulting in a simple structure and low cost.

[0274] Furthermore, if the second end surface **2132** corresponds to both the light-emitting module **33** and the light sensing module **32**, the area of the second end surface **2132** will be larger. Further, if the area of the first end surface **2131** is the same as that of the second end surface **2132**, the first end surface **2131** will also have a larger area, easily exposing internal electronic components (including the light sensing module **32**, the light-emitting module **33**, etc.) of the sensing device, allowing users to clearly see the internal structure from outside and affecting the overall aesthetic appearance of the sensing device. Therefore, in some embodiments of the present invention, the area of the second end surface **2132** is smaller than that of the first end surface **2131**, ensuring both the light sensing effect of the light sensing module **32** and the prompting effect of the indication region **211** while reducing exposure of internal electronic components. To enable most of the light in the first direction and the second direction to pass through the light-transmitting part **21**, specifically, the light sensing module **32** and the light-emitting module **33** are provided adjacent to each other.

[0275] It should be noted that the configuration form for making the area of the second end surface **2132** smaller than that of the first end surface **2131** is not limited. For example, the light guide member **213** may be tapered from its first end surface **2131** to its second end surface **2132**, so that the area of the second end surface **2132** is smaller than that of the first end surface **2131**. However, with such configuration, the overall volume of the light guide member **213** tends to be thicker in terms of production process, which may introduce bubbles during injection molding, affecting the light-guiding effect of the light guide member **213** and causing off-center and uneven illumination from the light-emitting module **33**. In this regard, referring to FIGS. **45** and **46**, in some embodiments of the present invention, the light guide member **213** is successively provided with a first light guide part **2133** and a second light guide part **2134** along the inner and outer directions of the sensing device. The first light guide part **2133** is provided as a truncated cone, with the first end surface **2131** formed on a side of the first light guide part **2133** away from the second light guide part **2134**, and the generatrix of the first light guide part **2133** is set as a concave curve. The second light guide part **2134** is cylindrical, with the second end surface **2132** formed on a side of the second light guide part **2134** away from the first light guide part **2133**, and the area of the second light guide part **2134** is the same as that of a side of the first light guide part **2133** close to the second light guide part **2134**. This arrangement prevents exposure of internal electronic components while reducing bubble generation during production due to the thinner second light guide part **2134**, enhancing the light guiding effect and ensuring centered and uniform light display of the light-emitting module **33** in the indication region **211** of the optical transceiver **2**.

[0276] Specifically, referring to FIGS. **45** and **46**, in some embodiments of the present invention, the trigger part **22** is implemented as a trigger post **221** for abutting against or approaching the detection switch **4** inside the sensing device, acting on the detection switch **4** in response to the first operating force to trigger the sensing device. This allows users to power on or network configuration of the sensing device by pressing the trigger part **22**. More specifically, based on the above embodiment where “the trigger part **22**, the light sensing region **212**, and the indication region **211** are sequentially distributed along the length direction of the optical transceiver **2**; the indication region **211** and the light sensing region **212** overlap; the first end surface **2131** of the light guide member **213** forms both the indication region **211** and light sensing region **212**, with its second end surface **2132** facing outwards from the sensing device and close to the light sensing module **32** and light-emitting module **33**”, the trigger post **221** and the light guide member **213** are sequentially distributed along the length direction of the optical transceiver **2**.

[0277] Specifically, in the present invention, the trigger part **22** can not only be displaced from an initial position to a trigger position under the first operating force to trigger the detection switch **4**, but also return from the trigger position to the initial position under a reset force after triggering the detection switch **4**. However, if the reset force is excessive, it may cause the trigger part **22** to have overdisplacement. Thus, after the trigger part **22** is reset to the initial position, it continues to move to a protruding position away from the housing **1**, which affects the user's subsequent feeling of use and also affects the aesthetic appearance of the microwave sensing apparatus **100**. It should be noted that the reset force can be understood as either another operating force applied by the user to the trigger part **22** after removal of the first operating force, or the elastic reset force exerted by the detection switch **4** on the trigger part **22** due to its elasticity after removal of the first operating force.

[0278] To address this, the present invention provides a limiting portion to restrict the movement range of the trigger part **22**. More specifically, referring to FIGS. **45** and **46**, in some embodiments of the present invention, the light-transmitting part **21** includes a pressing portion **214** and a bearing portion **215** stacked along the thickness direction of the light-transmitting part **21**. The pressing portion **214** has a smaller surface area than that of the bearing portion **215** and is adapted to fit into the mounting hole **111** on the sensing device, while the bearing portion **215** is provided inside the sensing device. That is, the surface area of the bearing portion **215** is larger than the hole area of the mounting hole **111**. Thus, when the trigger part **22** resets, the part of the bearing portion **215** moving towards the mounting hole **111** is restricted by the housing **1** of the sensing device, abutting against the inner side wall of the housing **1** and preventing movement beyond the mounting hole **111** or outside the housing **1**. This indirectly limits the movement range of the light-transmitting part **21**. More specifically, when the trigger part **22** is in the initial position, the bearing portion **215** abuts against the inner side wall of the housing **1**, further reducing the movement range of the light-transmitting part **21** to ensure precise resetting of the trigger part **22** and improve user experience.

[0279] Specifically, in the present invention, since the trigger part **22** is provided on the light-transmitting part **21**, the trigger part **22** triggers the detection switch **4** in response to the movement of the first operating force with respect to the sensing device. It can be understood that the rotation of the light-transmitting part **21** with respect to the sensing device drives the movement of the trigger part **22** to trigger the detection switch **4**, or the movement of the light-transmitting part **21** with respect to the sensing device drives the movement of the trigger part **22** to trigger the detection switch **4**. Thus, the connection between the light-transmitting part **21** and the sensing device varies accordingly.

[0280] Specifically, in some embodiments of the present invention, the light-transmitting part **21** is pivotally connected to the sensing device, enabling the light-transmitting part **21** to rotate relative to the sensing device about an axis extending along the third direction. The third direction is parallel to the horizontal direction of the light-transmitting part **21**. When the light-transmitting part **21** is subjected to the first operating force and undergoes pivotal movement, it drives the trigger part **22** to perform pivotal movement and activates the detection switch **4** by moving towards it.

[0281] Note that, referring to FIGS. **45** and **46**, the third direction is direction F1.

[0282] Further, the light-transmitting part **21** is provided with a rotating shaft **24** for pivotally connecting with the pivot hole **1121** of the sensing device; or the light-transmitting part **21** is provided with a pivot hole **1121** for pivotally connecting with the rotating shaft **24** of the sensing device. By the matching arrangement of the rotating shaft **24** and the pivot hole **1121**, the light-transmitting part **21** is pivotally connected to the sensing device, enabling convenient disassembly or assembly of the optical transceiver **2** and the sensing device.

[0283] Specifically, the light-transmitting part **21** rotates with respect to the sensing device, wherein one end of the two opposite ends of the light-transmitting part **21** is forced to move towards the inside of the sensing device, namely, forced to press down and move, and the other end is forced to move towards the outside of the sensing device, namely, forced to tilt up and move. More specifically, referring to FIG. **45**, in some embodiments of the present invention, the trigger part **22** is provided at one end of the light-transmitting part **21** in the fourth direction, and the indication region **211** and the light sensing region **212** are provided at the other end of the light-transmitting part **21** in the fourth direction. Based on the above embodiment where “the light-transmitting part **21** includes a pressing portion **214** and a bearing portion **215** stacked along its thickness direction, the surface area of the pressing portion **214** is smaller than that of the bearing portion **215**, and the pressing portion **214** is adapted to be provided in the mounting hole **111** formed on the sensing device, while the bearing portion **215** is provided inside the sensing device,” the bearing portion **215** has a first side surface **2151** connected to the pressing portion **214**, the first side surface **2151** has a first bearing surface **21511** corresponding to the indication region **211** and the light sensing region **212** of the light-transmitting part **21**, and a second bearing surface **21512** corresponding to the trigger part **22**. That is, when the light-transmitting part **21** rotates relative to the sensing device and the trigger part **22** triggers the detection switch **4**, the trigger part **22**, i.e., the second bearing surface **21512**, is pressed downwards, while the indication region **211** and the light sensing region **212**, i.e., the first bearing surface **21511**, are lifted upwards.

[0284] Further, the trigger part **22** moves between an initial position and a trigger position. When the trigger part **22** is in the initial position, the bearing portion **215** can be set to abut against the inner side wall of the housing **1** or have a gap with the inner side wall of the housing **1**. However, when the trigger part **22** is in the initial position and the bearing portion **215** is provided to abut against the inner side wall of the housing **1**, during the process of the trigger part **22** triggering the detection switch **4**, the first bearing surface **21511** may interfere with the inner side wall of the housing **1**, preventing the light-transmitting part **21** from rotating and thus affecting the movement of the trigger part **22**. Therefore, referring to FIGS. **45** and **46**, in some embodiments of the present invention, when the trigger part **22** is in the initial position, there is a movement gap between the first bearing surface **21511** and the inner side surface of the first wall **11**. In this way, during the process of the trigger part **22** triggering the detection switch **4**, the first bearing surface **21511** can rotate relative to the housing **1** by means of the movement gap, ensuring smooth user operation.

[0285] Further, to achieve the miniaturization design of the microwave sensing apparatus **100**, when the trigger part **22** is in the initial position, the first bearing surface **21511** is provided closer to the interior of the housing **1** compared to the second bearing surface **21512**, and the second bearing surface **21512** abuts against the first wall **11**. This reduces the space occupied by the bearing portion **215** inside the housing **1** while ensuring that the first bearing surface **21511** can rotate relative to the housing **1** for smooth user operation, thereby reducing the volume of the housing **1**. More specifically, in an embodiment of the present invention, the maximum trigger stroke of the detection switch **4** is 0.2 mm. When the trigger part **22** is in the initial position, the trigger part **22** abuts against the detection switch **4**. Accordingly, the movement gap between the first bearing surface **21511** and the inner side surface of the first wall **11** is set to 0.25 mm.

[0286] Specifically, the rotating shaft **24** or the pivot hole **1121** on the light-transmitting part **21** corresponds to the connection between the first bearing surface **21511** and the second bearing surface **21512**, or the rotating shaft **24** or the pivot hole **1121** on the light-transmitting part **21** corresponds to the first bearing surface **21511**. This ensures that during the rotation of the light-transmitting part **21**, the trigger part **22** can be fully pressed downwards, i.e., the trigger part **22** rotates to the correct position to fully trigger the detection switch **4**, avoiding failure of the detection switch **4**. At the same time, during the rotation of the light-transmitting part **21**, the part corresponding to the light sensing module **32** and/or the light-emitting module **33** is prevented from being pressed downwards and acting on the light sensing module **32** and/or the light-emitting module **33**, thereby avoiding damage to the light sensing module **32** and/or the light-emitting module **33** due to excessive pressing or repeated use, which would affect their service life.

[0287] Of course, in other embodiments of the present invention, the light-transmitting part **21** moves relative to the housing **1** to drive the trigger part **22** to trigger the detection switch **4**. Specifically, the light-transmitting part **21** is provided with an elastic connection structure **23** for thermal fusion connection with the sensing device. The elastic connection structure **23** can elastically stretch and compress due to its elasticity. That is, when the trigger part **22** is pressed downwards by the first operating force, the elastic connection structure **23** is elastically compressed, allowing the trigger part **22** to move towards the interior of the sensing device to trigger the detection switch **4**. When the first operating force is removed, the elastic connection structure **23** generates an elastic reset force to elastically stretch and act on the trigger part **22**, causing it to move towards the exterior of the housing **1** to return to the initial position.

[0288] It should be noted that the connection method between the elastic connection structure **23** and the housing **1** is not limited and may include snap connection, adhesive connection, etc.

[0289] Further, referring to FIGS. **24**, **45**, and **46**, in some embodiments of the present invention, the light-transmitting part **21** is provided with an elastic connection structure **23**, which includes at least two elastic connection arms **231**. The two elastic connection arms **231** are provided on opposite sides of the light-transmitting part **21** for thermal fusion connection with the heat-melting post **114** of the sensing device. In other words, the elastic connection structure **23** is fixedly connected to the housing **1** by thermal fusion, ensuring stable connection. It should also be noted that the form of the elastic connection arms **231** is not limited. They may be straight or curved. Specifically, in some embodiments of the present invention, the elastic connection arms **231** are curved, making them more prone to elastic deformation under force and easier for users to operate.

[0290] It should be noted that in the present invention, the two technical features that “the light-transmitting part **21** is provided with a rotating shaft **24** for pivotally connecting with the pivot hole **1121** of the sensing device; or the light-transmitting part **21** is provided with a pivot hole **1121** for pivotally connecting with the rotating shaft **24** of the sensing device” and “the light-transmitting part **21** is provided with an elastic connection structure **23** for thermal fusion connection with the sensing device” can be arranged alternatively or simultaneously. Specifically, in some embodiments of the present invention, the above two technical features are set simultaneously. Further, the elastic connection structure **23** corresponds to the trigger part **22**, and the rotating shaft **24** and the pivot hole **1121** correspond to the junction of the first bearing surface **21511** and the second bearing surface **21512**. That is, when the trigger part **22** is subjected to the first operating force, the light-transmitting part **21** can pivot relative to the housing **1**, and by the compression of the elastic connection structure **23**, the trigger part **22** can be pressed inwards to trigger the detection switch **4**, while the indication region **211** and the light sensing region **212** are lifted outwards. When the first operating force is removed, the trigger part **22** is subjected to the elastic force of the elastic connection structure **23** to return to the initial position, and the indication region **211** and the light sensing region **212** also return to their original positions, completing the operation. This improves the rotational stability of the light-transmitting part **21**, while the trigger part **22** can automatically reset by the elastic connection structure **23**, making the user operation very effortless.

[0291] Specifically, in the present invention, the material of the light-transmitting part **21** is a transparent material. The material of the light-transmitting part **21** has good light transmittance, allowing the light-transmitting part **21** to not only transmit light in the second direction to be received by the light sensing module **32** but also to display the light in the first direction clearly and brightly in the indication region **211**. Further, the transparent material may be transparent glass or transparent PC plastic. Specifically, in some embodiments of the present invention, the material of the light-transmitting part **21** is transparent PC plastic, which has low production cost and elasticity. Compared to the transparent glass, it is less prone to damage upon collision or falling, offering high practicality.

[0292] Further, referring to FIGS. **45** and **46**, based on the above embodiment where “the light-transmitting part **21** includes an indication region **211** and a light sensing region **212**. The indication region **211** allows light in the first direction to pass through, while the light sensing region **212** allows light in the second direction to enter”, the optical transceiver **2** further includes a decorative member **25**. The decorative member **25** is provided on a side of the light-transmitting part **21** away from the interior of the sensing device and includes a shielding region **251** and a light-transmitting region **252**. The shielding region **251** corresponds to the trigger part **22**, and the light-transmitting region **252** corresponds to the indication region **211** and light sensing region **212**. The shielding region **251** prevents excessive exposure of the internal electronic components of the housing **1** and helps the users distinguish the positions of the trigger part **22**, the light sensing region **212**, and the indication region **211**. More specifically, in some embodiments of the present invention, the decorative member **25** is adhesively bonded to the light-transmitting part **21**, simplifying assembly.

[0293] Further, during the assembly of the decorative member **25** and the light-transmitting part **21**, the misassembly may occur due to positioning accuracy issues, leaving part of the light-

transmitting part **21** uncovered by the decorative member **25**, exposing some internal electronic components and affecting the appearance. To address this, referring to FIGS. **45** and **46**, the light-transmitting part **21** includes a pressing portion **214** and a bearing portion **215** stacked along the thickness direction of the light-transmitting part **21**. The pressing portion **214** has a smaller surface area than that of the bearing portion **215** and is provided in the mounting hole **111** of the sensing device, while the bearing portion **215** is provided inside the sensing device. The decorative member **25** corresponds to the pressing portion **214** and is adapted to the mounting hole **111**. Thus, the surface area of the decorative member **25** is larger than that of the pressing portion **214**, offsetting the impact of positioning errors during the assembly of the decorative member **25** and the light-transmitting part **21** and ensuring that the light-transmitting part **21** is completely covered by the decorative member **25**, preventing exposure of the internal electronic components of the housing **1**.
[0294] Specifically, in some embodiments of the present invention, the decorative member **25** is an acrylic sheet, and the shielding region **251** is formed by screen printing. The acrylic sheet has low cost but good transparency and light transmission properties. Therefore, by screen printing part of the acrylic sheet to form the shielding region **251**, it can not only avoid exposing the structure of electronic components inside the housing **1**, but also improve the aesthetic appearance of the optical transceiver **2**.
[0295] As shown in FIG. **47**, a schematic flowchart of a microwave sensing method using the above microwave sensing apparatus is provided. It should be noted that the related terms, circuit components, and principles in this embodiment can be interpreted with reference to the descriptions in the related embodiments of the microwave sensing apparatus, and the same parts will not be repeated here. Specifically, the microwave sensing method provided in this embodiment includes:
[0296] S1, changing sensing parameters in response to at least one trigger signal produced by at least one selected operation performed on the electronic device when communicatively connected to the electronic device; wherein the sensing parameters are used to select at least one sub-sensing region; the sub-sensing region is associated with a target sensing region, enabling the target sensing region to be flexibly divided based on different selected operations received by the electronic device; and [0297] S2, forming sensing results by detecting a moving object within the target sensing region.
[0298] Based on the above method, it can be understood that in the embodiment of the present invention, the microwave sensing apparatus can adjust its sensing parameters in response to selected operations received by an electronic device to adjust the corresponding target sensing region. This allows the target sensing region of the microwave sensing apparatus to be flexibly adjusted based on the electronic device, enabling the target sensing region to be flexibly changed according to different sensing range requirements, thereby improving the applicability of the microwave sensing apparatus.
[0299] The microwave sensing apparatus changes sensing parameters based on the selected operation to flexibly set the target sensing region, which includes multiple approaches.
[0300] In an optional first approach, the sensing parameter includes a maximum sensing distance value for defining a maximum sensing distance of a sub-sensing region;
[0301] The changing sensing parameters in response to at least one trigger signal produced by at least one selected operation performed on the electronic device when communicatively connected to the electronic device specifically includes: [0302] changing the maximum sensing distance value in response to at least one trigger signal generated by at least one selected operation performed on the electronic device when communicatively connected to the electronic device, such that a maximum sensing distance of the target sensing region including the sub-sensing region can be flexibly set.
[0303] Furthermore, in this embodiment, the microwave sensing apparatus can adjust the maximum sensing distance among the sensing parameters based on the selected operation of the electronic device, thereby enabling flexible setting of the maximum sensing distance of a target

sensing region originating from the microwave sensing apparatus to accommodate different maximum sensing distance requirements.
[0304] In an optional second approach, the sensing parameter includes a minimum sensing distance value for defining a minimum sensing distance of a sub-sensing region;
[0305] The changing sensing parameters in response to at least one trigger signal produced by at least one selected operation performed on the electronic device when communicatively connected to the electronic device specifically includes: [0306] changing the minimum sensing distance value in response to at least one trigger signal generated by at least one selected operation on an electronic device when communicatively connected to the electronic device, such that a minimum sensing distance of the target sensing region including the sub-sensing region can be flexibly set.
[0307] Furthermore, in this embodiment, the microwave sensing apparatus can adjust the minimum sensing distance among the sensing parameters based on the selected operation of the electronic device, thereby enabling flexible setting of the minimum sensing distance of the target sensing region of the microwave sensing apparatus.
[0308] In an optional third approach, the sensing parameters include at least one segment range starting from a first distance value and ending at a second distance value, for instructing the sensing module to divide a sub-sensing region having the first distance value as a minimum sensing distance value and the second distance value as a maximum sensing distance value; where the first distance value is less than the second distance value and greater than zero;
[0309] The changing sensing parameters in response to at least one trigger signal produced by at least one selected operation performed on the electronic device when communicatively connected to the electronic device specifically includes: [0310] changing the first distance value and/or the second distance value in response to at least one trigger signal generated by at least one selected operation on an electronic device when communicatively connected to the electronic device, thereby varying a minimum sensing distance and/or maximum sensing distance of the target sensing region including the sub-sensing region.
[0311] Furthermore, in this embodiment, the communication module can adjust the minimum sensing distance and maximum sensing distance among the sensing parameters based on the selected operation of the electronic device, thereby enabling flexible setting of the minimum sensing distance and the maximum sensing distance of the target sensing region of the microwave sensing apparatus.
[0312] In an optional fourth approach, the sensing parameter includes a plurality of sets of designated segment ranges, each segment range used to instruct the microwave sensing apparatus to divide a sub-sensing region with the starting point of the segment range as the minimum sensing distance value and the ending point as the maximum sensing distance value.
[0313] The changing sensing parameters in response to at least one trigger signal produced by at least one selected operation performed on the electronic device when communicatively connected to the electronic device specifically includes: [0314] selecting one or more sets of sub-sensing regions corresponding to the segment ranges indicated by the selected instruction in response to at least one trigger signal generated by at least one selected operation on an electronic device when communicatively connected to the electronic device, thereby enabling precise setting of the target sensing region based on the selected sub-sensing regions.
[0315] Based on the above description, it can be understood that with the technical solution provided in this embodiment, the users can form a plurality of sub-sensing regions with respective segment ranges by dividing a whole region into segments. This allows users to select the sub-sensing regions corresponding to the segment ranges based on the position of the region to be sensed, thereby forming a precise target sensing region. Defining each sub-sensing region by the segment range only requires setting the minimum and maximum distance boundaries of each sub-sensing region. Compared to dividing sub-sensing regions using coordinate values, angle values, etc., the boundary values of each sub-sensing region in the solution provided in this embodiment

can be easily divided based on the distance values detected by the microwave sensing apparatus. The division of each sub-sensing region in this embodiment can be achieved by the microwave sensing apparatus with the basic distance detection function, thereby reducing implementation costs.

[0316] Based on the above optional third approach, a plurality of sets of designated segment ranges can be combined to form a complete range, where the plurality of sets of segment ranges are non-completely overlapping. Thus, the microwave sensing apparatus can select a plurality of non-overlapping segment ranges based on a selected operation, enabling the target sensing region to be discontinuously combined by a plurality of discontinuous sub-sensing regions.

[0317] Therefore, based on the technical solution provided in this embodiment, a discontinuous target sensing region can be formed by the users by discontinuous selection of different sub-sensing regions corresponding to a plurality of discontinuous regions to be sensed, thereby improving the accuracy of the target sensing region's coverage of each region to be sensed.

[0318] The microwave sensing apparatus can establish a communication connection with the electronic device in multiple ways.

[0319] In one specific implementation of establishing a communication connection, the changing sensing parameters in response to at least one trigger signal produced by at least one selected operation performed on the electronic device when communicatively connected to the electronic device specifically includes:

[0320] A communication connection with an electronic device having a display interface is established by a designated network in a state of being communicatively connected to the designated network, thereby changing sensing parameters according to at least one different selected operation associated with a representation of the sensing parameter with respect to a display interface of the electronic device.

[0321] It should be noted that, as described in the above embodiments, the term “representation” in this embodiment and the following refers to any user-interactive graphical display interface object optionally displayed on the display interface of the electronic device. For example, images (e.g., curves, icons), sliders, and text (e.g., words, hyperlinks) in FIGS. **3-7**, **9**, **11**, **12**, and **14** of the drawings optionally each constitute corresponding representations.

[0322] Furthermore, with the technical solution provided in this embodiment, the users can connect an electronic device (e.g., a smartphone) and the microwave sensing apparatus to the same designated network to indirectly establish a communication connection between them via the designated network. This allows convenient setting of the target sensing region of the microwave sensing apparatus by the display interface on the electronic device, and the visual selected operation facilitates more accurate division of the target sensing region for specific application scenarios.

[0323] Further, the microwave sensing method further includes: [0324] sending a first result out, in a case that the sensing result within a specified time is the first result of a plurality of sensing results, to enable the electronic device to form a representation characterizing the first result on the display interface thereof in response to the first result; wherein the specified time is set by the electronic device according to a setting operation received by the display interface thereof; and the first result characterizes that no moving object is detected within the target sensing region.

[0325] Furthermore, in this embodiment, the microwave sensing apparatus will not upload it immediately when detecting that the sensing result is the first result, but will not upload it until a specified time is delayed and the first result is continuously detected for a specified time, so as to reduce the amount of data to be uploaded.

[0326] Further, the microwave sensing method further includes: [0327] calculating a duration time of a first result to form a fourth result sent out when the sensing result is a first result of the plurality of sensing results, such that the electronic device can form a representation characterizing the fourth result on the display interface thereof in response to the fourth result.

[0328] Furthermore, in this embodiment, when the sensing result is the first result, the display interface of the electronic device displays the first result for a duration time to form a representation of the fourth result that is convenient for a user to view.
[0329] Specifically, the microwave sensing method further includes:
[0330] executing a command from an application program to change the specified time. The application may be an application program (app) running on an intelligent terminal (such as the electronic device). In other words, a user can adjust the specified time by any intelligent terminal running a related application and establishing a communication connection with the microwave sensing apparatus, so as to change the delayed reporting time of the first result, making the update rule of the first result on the display interface of the electronic device applicable to specific application scenarios.
[0331] Further, the microwave sensing method further includes: [0332] immediately sending a second result out when the sensing result is a second result of a plurality of sensing results, to enable the electronic device to form a representation characterizing the second result on the display interface thereof in response to the second result, wherein the second result characterizes that the moving object is detected within the target sensing region.
[0333] Furthermore, in this embodiment, when the microwave sensing apparatus detects that the sensing result is the second result, it will upload the sensing result immediately, allowing users to promptly grasp the triggering result of moving objects within the target sensing region.
[0334] Further, the microwave sensing method further includes: [0335] calculating a duration time of a second result to form a sixth result to be sent out when the sensing result is a second result of the plurality of sensing results, such that the electronic device can form, in response to the sixth result, a representation characterizing the sixth result via the display interface thereof.
[0336] Furthermore, in this embodiment, when the sensing result is a second result, the display interface of the electronic device displaying the second result for a duration time to form a representation of the sixth result which is convenient for a user to view.
[0337] Further, the microwave sensing method further includes: when the sensing result is the second result, controlling a light-emitting module to emit an indication signal of a specified pattern to visually inform the user that the second result is triggered.
[0338] Specifically, the indication signal of the specified pattern includes flashing a light signal of a specified color at a certain periodic frequency.
[0339] Further, the microwave sensing method further includes: [0340] periodically sending a third result of the plurality of sensing results out, to enable the electronic device to form a representation characterizing the third result on the display interface thereof in response to the third result; [0341] wherein the third result characterizes the distance between the moving object within the target sensing region and the sensing module.
[0342] Specifically, the obtaining the third result includes: [0343] detecting the position parameters of moving objects in the target sensing region to form the third result of a plurality of sensing results.
[0344] Thus, based on this embodiment, the microwave sensing apparatus can obtain the distance value of moving objects within the target sensing region.
[0345] Further, after detecting the position parameters of moving objects in the target sensing region to form the third result of a plurality of sensing results, the method further includes:
[0346] judging the movement direction of moving objects in the target sensing region based on the change trend of the third result within a specified period, wherein the movement direction includes moving closer and away.
[0347] Based on the above embodiment, further, the microwave sensing method also includes:
[0348] setting a specified boundary and determining whether the moving object crosses the specified boundary based on the third result.
[0349] Thus, the microwave sensing method further includes: [0350] sending a fifth result out

when the sensing result is the fifth result of a plurality of sensing results, so as to enable the electronic device to form a representation characterizing the fifth result on the display interface thereof in response to the fifth result; the fifth result characterizes a moving object within the target sensing region passing through a specified boundary within the target sensing region in a manner of moving closer and away.

[0351] Thus, based on this embodiment, the microwave sensing apparatus can determine whether moving objects in the target sensing region cross the specified boundary and display corresponding information on the display interface of an electronic device, allowing the users to promptly review related triggering situations.

[0352] Further, the microwave sensing apparatus changes the specified boundary by executing commands from an application.

[0353] Further, the microwave sensing method further includes: [0354] reporting the sensing result via the designated network in a state of being connected to the designated network, so that a gateway device and/or a cloud server connected to the designated network can receive the sensing result and control a defined control result to be executed according to a target control relationship matching the sensing result in at least one pre-set control relationship; wherein the control relationship defines a mapping relationship between at least one of a plurality of sensing results and at least one control result; and the control result is an executable function of one controlled device connected to the designated network.

[0355] Thus, based on the technical solution provided by this embodiment, the microwave sensing apparatus can achieve diverse and complex intelligent linkage requirements by freely defining control relationships between various sensing results and executable functions of controlled devices connected to the designated network.

[0356] Further, the control result also includes adjusting the indication lamp signal of the microwave sensing apparatus. Thus, the microwave sensing apparatus can simultaneously link external electrical devices and its own indication lamp signals.

[0357] Further, after obtaining the sensing results, the method further includes: [0358] controlling the power supply of an external electrical device based on the sensing results according to preset control logic.

[0359] Optionally, the controlling the power supply of an external electrical device based on the sensing results according to preset control logic specifically includes: [0360] controlling the power supply of the electrical device by turning on or off a relay connected to the power supply circuit of the external electrical device.

[0361] Optionally, the microwave induction method further includes: [0362] detecting illumination intensity by a light sensing module electrically connected to the communication module.

[0363] Optionally, the microwave sensing method further includes: [0364] periodically acquiring illumination intensity data via the light sensing module and upload it, enabling the electronic device to respond to the illumination intensity data and form a representation associated with the illumination intensity data on the display interface thereof

[0365] Thus, the microwave sensing apparatus can detect current illumination intensity by the light sensing module, providing the users with reference data for setting intelligent scenarios and forming the basis for trigger condition settings in intelligent scenarios.

[0366] Optionally, the microwave sensing method further includes: [0367] uploading acquired illumination intensity data at predetermined intervals, or uploading the acquired illumination intensity data when the change between two consecutive acquisitions exceeds a specified threshold, enabling the electronic device to respond to the illumination intensity data and form a representation associated with the illumination intensity data on the display interface thereof.

[0368] Thus, based on this solution, the illumination intensity data is only reported when changes exceed a specified threshold or at predetermined intervals, not in real-time, significantly reducing data reporting when illumination intensity data changes are minimal.

[0369] Optionally, the microwave sensing method further includes: [0370] reporting the illumination intensity via the designated network when connected to it, enabling a gateway device and/or cloud server connected to the designated network to receive the illumination intensity data and execute a defined control result according to a target control relationship matching the illumination intensity among at least one preset control relationship, wherein the control relationship defines a mapping relationship between illumination intensity of at least one specified condition and at least one control result; and the control result is an executable function of a controlled device connected to the designated network.
[0371] The control relationship and control result in this embodiment can be understood with reference to the above embodiment and are not detailed here. The difference is that the trigger condition for intelligent scenarios in this embodiment is illumination intensity. Users can set reasonable mapping relationships based on illumination intensity values from each time period in the fitting curve, ensuring that the control results are executed more appropriately.
[0372] Further, the microwave sensing method further includes: [0373] turning off the indication lamp when obtaining illumination intensity data by the light sensing module.
[0374] Optionally, the control result also includes adjusting the signal emitted by the indication lamp of the microwave sensing apparatus. Thus, the microwave sensing apparatus can simultaneously link external electrical devices and its own indication lamp signals.
[0375] Optionally, after obtaining the illumination intensity, the method further includes: [0376] controlling the power supply of an external electrical device based on the illumination intensity according to preset control logic.
[0377] Optionally, the controlling the power supply of an external electrical device based on the illumination intensity according to preset control logic specifically includes: [0378] controlling the power supply of the electrical device by turning on or off a relay connected to the power supply circuit of the external electrical device.
[0379] Optionally, the light sensing module includes a visible light photoelectric probe and an infrared light photoelectric probe. The light sensing module is configured to obtain the illumination intensity by processing the illumination data of the visible light photoelectric probe and the illumination data acquired by the infrared light photoelectric probe with a preset algorithm. The preset algorithm can be understood by reference to the relevant descriptions of the above embodiments and will not be described here.
[0380] It should be noted that the communication module can access the designated network in various ways to establish a communication connection with the electronic device. An embodiment of the present invention provides a preferred implementation. Specifically, in this embodiment, the establishing a communication connection with an electronic device having a display interface by the designated network in a state of being communicatively connected to the designated network includes: [0381] entering a network configuration mode in response to a specified network configuration operation and sending a designated network configuration signal out, enabling a networked device receiving the designated network configuration signal to instruct the microwave sensing apparatus to connect to the designated network in response to the designated network configuration signal, thereby establishing a communication connection with at least one electronic device having a display interface by the designated network when the microwave sensing apparatus is connected to the designated network.
[0382] Herein, the network configuration mode can be entered in an unconfigured state or by resetting in a configured state. Thus, in one example, the entering the network configuration mode in response to a specified network configuration operation specifically includes: determining that the microwave sensing apparatus enters the network configuration mode in response to at least one trigger signal brought by the specified network configuration operation in an unconfigured state. In another example, the entering the network configuration mode in response to a specified network configuration operation specifically includes: determining that the microwave sensing apparatus is

reset and enters the network configuration mode in response to at least one trigger signal brought by the specified network configuration operation in a configured state.
[0383] In the network configuration mode, a network configuration message is generated and sent out, so that after receiving the network configuration message, the designated device instructs the microwave sensing apparatus to join the designated network to complete the network configuration. The designated device includes an intelligent terminal device and/or a gateway device. After completing the network configuration, the microwave sensing apparatus can communicate with the gateway device by the designated network, and further communicate with the electronic device connected to the designated network by the gateway. Based on the above description, it should be understood that completing the network configuration mode should be understood as a mode in which the microwave sensing apparatus can perform data transmission with the gateway device after successfully joining the designated network. Furthermore, this embodiment provides a preferred implementation for the network configuration of the microwave sensing apparatus. Based on this implementation, the microwave sensing apparatus can be quickly discovered by intelligent terminal devices and/or gateway devices based on the network configuration message sent after entering the network configuration mode, and then instructed to join the designated network, thereby improving the network access efficiency of the microwave sensing apparatus.
[0384] Optionally, when the microwave sensing apparatus transmits the network configuration message out, it specifically includes: controlling an indication lamp connected to the communication module to emit a first prompt signal before transmitting the network configuration message. This prompts the user that the microwave sensing apparatus is about to enter the network configuration mode.
[0385] Optionally, when the microwave sensing apparatus transmits the network configuration message out, it specifically includes sending the network configuration message at a specified network configuration interval.
[0386] Optionally, during the network configuration of the microwave sensing apparatus, the method further includes: controlling an indication lamp to emit a second prompt signal; and at least one of the following is different in the first prompt signal and the second prompt signal: [0387] flashing frequency; and [0388] color.
[0389] Thus, based on the technical solution provided in this embodiment, the user can easily distinguish the current state of the microwave sensing apparatus and confirm whether it has entered the network configuration mode based on the differences between the first prompt signal and the second prompt signal.
[0390] Optionally, the microwave sensing apparatus stops sending the network configuration message out and stops emitting the second prompt signal after successful network configuration. Furthermore, when the user observes the presence of the second prompt signal, it can be determined that the microwave sensing apparatus is currently in the network configuration mode. When the second prompt signal disappears, it can be determined that the microwave sensing apparatus has been successfully configured.
[0391] Optionally, the microwave sensing method further includes: [0392] when operating in the network configuration mode after completing network setup, periodically send reminder messages at predetermined intervals, thereby enabling the electronic device and the gateway to verify the online status of the microwave sensing apparatus upon receiving the reminder messages.
[0393] It will be appreciated that both the microwave sensing apparatus and microwave sensing method in the above embodiments are applicable to the detection of moving objects, which may include movable organisms such as cats, dogs, humans, or non-living objects with specific mobility like robotic vacuum cleaners. Furthermore, for specific applications of human presence sensing, an embodiment of the present invention provides a microwave sensing apparatus applicable only to human presence detection, and proposes a microwave sensing method based on this device. It

should be noted that relevant terms, components, and usage principles in this embodiment can be understood by referring to the descriptions of related embodiments and accompanying drawings above, and identical parts will not be repeated here.

[0394] Referring to FIG. **2**, the microwave sensing apparatus in this embodiment is specifically adapted to establish a communication connection with an electronic device **200** having a display interface by a designated network in a state of being communicatively connected to the designated network. The microwave sensing apparatus includes: [0395] a communication module **5** configured to obtain a selected instruction corresponding to different selected operations performed on at least one representation associated with sensing parameters on the display interface of the electronic device **200**; [0396] a sensing module **31** directly or indirectly communicatively connected to the communication module **5** and adapted to receive and execute the selected instructions sent by the communication module **5** to change sensing parameters; wherein the sensing parameters are used to select at least one sub-sensing region; the sub-sensing region is associated with a target sensing region, enabling the target sensing region to be dynamically formed based on different selected operations received by the electronic device **200**; and the communication module **5** forms sensing results by detecting a moving human body within the target sensing region by the sensing module **31**.

[0397] Based on the technical solution provided in this embodiment, it can be seen that in the embodiment of the present invention, the communication module **5** establishes a communication connection with an electronic device **200** and adjusts the sensing parameters of the sensing module **31** based on the selected operation received by the electronic device **200** to adjust the target sensing region of the microwave sensing apparatus, thereby flexibly adjusting the target sensing region of the microwave sensing apparatus based on the electronic device **200**, enabling the target sensing region to be flexibly changed based on different sensing range requirements, and improving the applicability of the microwave sensing apparatus. Additionally, the electronic device **200** has a display interface. Users can connect the electronic device **200** (e.g., a smartphone) and the microwave sensing apparatus to the same designated network, and then conveniently set the target sensing region of the microwave sensing apparatus by the display interface on the electronic device **200**. The visual selected operation method allows the users to make more accurate divisions of the target sensing region for specific application scenarios. In one optional method for setting target sensing distances, the sensing parameters include a maximum sensing distance value to define the maximum sensing distance of a sub-sensing region. The sensing module **31** is further configured to change the maximum sensing distance value based on a selected instruction, so that the maximum sensing distance of a target sensing region including the sub-sensing region can be flexibly set. This enables modification of the coverage range of the target sensing region starting from the microwave sensing apparatus by adjusting the maximum sensing distance, thereby accommodating different sensing distance requirements. In another optional method for setting target sensing distances, the sensing parameters include a minimum sensing distance value to define the minimum sensing distance of a sub-sensing region. The sensing module **31** is further configured to change the minimum sensing distance value based on a selected instruction, so that the minimum sensing distance of a target sensing region including the sub-sensing region can be flexibly set.

[0398] In yet another optional method for setting target sensing distances, the sensing parameters include at least one segment range starting from a first distance value and ending at a second distance value, for instructing the sensing module **31** to divide a sub-sensing region having the first distance value as a minimum sensing distance boundary value and the second distance value as a maximum sensing distance boundary value; where the first distance value is less than the second distance value and greater than zero; the communication module **5** is further configured to enable the sensing module **31** to vary the first distance value and/or the second distance value based on a selected instruction, thereby changing the minimum sensing distance and/or maximum sensing distance of a target sensing region including the sub-sensing region.

[0399] In still another optional method for setting target sensing distances, the sensing parameters include a plurality of sets of designated segment ranges, wherein each of the segment ranges is configured to instruct the sensing module **31** to divide a sub-sensing region having a minimum sensing distance value at a starting point of the segment range and a maximum sensing distance value at an ending point of the segment range; the communication module **5** is further configured to enable the sensing module **31** to select, based on a selected instruction, one or more sets of sub-sensing regions corresponding to the segment range to which the selected instruction is directed, so that the target sensing region can be precisely set according to the different sub-sensing regions selected.

[0400] Furthermore, the plurality of sets of designated segment ranges can be combined to form a complete range, each set of segment ranges being non-completely overlapping, enabling the sensing module **31** to select at least two non-overlapping segment ranges based on a selected instruction, thereby allowing the target sensing region to be combined in a discontinuous manner by a plurality of discontinuous sub-sensing regions. For example, in some application scenarios such as an office setting, the regions where workstations are located are the regions to be sensed. After detecting moving objects at each workstation, some electrical devices (e.g., turning on lights) can be activated. The corridors between workstations are non-sensing regions. If an existing microwave sensing apparatus with only overall region sensing function is used to cover multiple workstations, the corridor regions between adjacent workstations will inevitably be covered, resulting in inaccurate coverage of the regions to be sensed. However, based on the technical solution disclosed in this embodiment, the target sensing region can be formed by discontinuous selection of the segment ranges corresponding to the sub-sensing regions where each workstation is located, thereby excluding non-sensing regions such as corridors and achieving precise coverage of each workstation region by the target sensing region.

[0401] Additionally, the sensing results should be understood as one or multiple types of results, meaning the communication module **5** can output one or multiple sensing results based on processing the detection results from the sensing module **31**. Furthermore, one or more of a plurality of sensing results may also be in the sensing results sent out, and the plurality of sensing results may be sent out via one control message, or may be sent out via multiple control messages respectively.

[0402] Optionally, the communication module **5** is further configured to send the first result out when the sensing result continuously remains as the first result of a plurality of sensing results within the specified time, so that the electronic device **200** can receive the first result and display a representation characterizing the first result on the display interface thereof (refer to FIG. **23**). The specified time is set by the electronic device **200** according to setting operations received by the display interface thereof. The first result indicates that no moving human body is detected within the target sensing region. Thus, in this embodiment, the communication module **5** does not immediately upload the result when detecting “no human presence” (first result), but delays upload until this result persists for the specified time and continues to be detected during the specified time, thereby reducing the data transmission volume. In addition, in some intelligent linkage scenarios, the sensing result “no human presence” is generally linked with a control result of turning off an electrical device, for example, turning off a corresponding lamp if the sensing result “no human presence” is set, or turning off an air conditioner if the sensing result “no human presence” is set, or the like. In such linkage scenarios, the accuracy of “no human presence” sensing results is crucial, as momentary detections may be erroneous. By requiring continuous “no human presence” sensing results over a specified time before upload, this approach reduces false alarm rates, preventing unintended shutdowns of electrical devices when people are actually present and thus improving user experience.

[0403] Optionally, the communication module **5** is further configured and adapted to calculate a duration time of a first result to form a fourth result sent out when the sensing result is a first result of the plurality of sensing results, such that the electronic device **200** can form a representation characterizing the fourth result on the display interface thereof in response to the fourth result (refer to FIG. **48**). Thus, in this embodiment, when the sensing result is the first result, the display interface of the electronic device **200** will display the duration of the first result to form a representation of the fourth result for user viewing. Thus, the result can also be set as a trigger condition in the control relationship.

[0404] Optionally, the communication module **5** is further configured to execute a command from an application program to change the specified time.

[0405] Optionally, the communication module **5** is further configured to immediately send a second result out when the sensing result is a second result of a plurality of sensing results, to enable the electronic device **200** to form a representation characterizing the second result on the display interface thereof in response to the second result (refer to FIG. **49**). The second result characterizes that the moving human body is detected within the target sensing region. Furthermore, in this embodiment, when the communication module **5** detects that the sensing result indicates human presence in the target sensing region, it immediately uploads this sensing result to the designated network. This allows the users to promptly monitor trigger results of moving objects in the target sensing region and facilitates triggering of control results corresponding to preset linkage control relationships based on the designated network settings, thereby improving linkage scenario triggering efficiency.

[0406] Optionally, the communication module **5** is further configured and adapted to calculate a duration time of a second result to form a sixth result to be sent out when the sensing result is a second result of the plurality of sensing results, such that the electronic device **200** can form, in response to the sixth result, a representation characterizing the sixth result via the display interface thereof (refer to FIG. **49**). Furthermore, in this embodiment, when the sensing result is “human presence”, the duration time of this state (“human presence duration time”) is reported to the designated network. The preset linkage control relationship can set this sixth result as a trigger condition to link corresponding control results, while the display interface of the electronic device **200** will display the duration time of the second result, forming a user-friendly representation of the sixth result.

[0407] Optionally, the microwave sensing apparatus further includes a light-emitting module **33** electrically connected to the communication module **5**, the communication module **5** being further configured to control the light-emitting module **33** to emit an indication signal of a specified rule when the sensing result is a second result. Thus, the user is visually informed that the second result is triggered by the indication signal conforming to the specified rule. In one example, the indication signal of the specified pattern includes flashing a light signal of a specified color at a certain periodic frequency. Thereby, the user can know that the second result is triggered when he or she sees that the flashing light signal is emitted from the microwave sensing apparatus.

[0408] Optionally, the communication module **5** is further configured to periodically transmit a third result of a plurality of sensing results when the sensing result continuously remains as the second result, enabling the electronic device **200** to display a representation characterizing the third result on the display interface thereof in response to the third result (refer to FIG. **50**). The third result characterizes the distance between the moving human body within the target sensing region and the sensing module **31**. Specifically, the sensing module **31** is further configured to detect position parameters of a moving human body within the target sensing region, and the communication module **5** acquires these position parameters and processes them to form the third result of a plurality of sensing results.

[0409] Thus, based on this embodiment, the communication module **5** can obtain the distance value between the human body and the sensing module **31** when detecting a person's presence in the target sensing region, allowing the communication module **5** to derive other sensing results by correlation calculations with this distance value. For example, movement trends of the human body

can be jointly determined based on the distance value, and then: In one embodiment, the communication module **5** is further configured to judge the movement direction of a moving human body within the target sensing region based on the trend of change in the third result over a specified period. The movement direction includes both moving away and closer. In a specific example, the communication module **5** determines the movement direction of the human body by analyzing the distance value (third result) of the human body within 1 second, and determines that the human body approaches in the direction towards the microwave sensing apparatus if the distance value obtained within 1 second is gradually decreased, and otherwise determines that the human body is moved away from the microwave sensing apparatus.
[0410] Furthermore, in some embodiments, the communication module **5** is also configured to set a specified boundary and determine whether the moving human body crosses this specified boundary based on the third result. For example, if the specified boundary is set at a distance value of 5 meters, and the distance value crosses this 5-meter boundary within a specified period. It is determined that the human body has crossed the specified boundary. Thus,
[0411] In an embodiment, based on determining whether the human body crosses the specified boundary and determining the movement direction of the moving object, the communication module **5** is further configured to send a fifth result out when the sensing result is the fifth result of a plurality of sensing results, so as to enable the electronic device to form a representation characterizing the fifth result on the display interface thereof in response to the fifth result; the fifth result characterizes a moving human body within the target sensing region passing through a specified boundary within the target sensing region in a manner of moving closer and away.
[0412] When the sensing result is “someone approaching” or “someone departing”, this result will be reported to a designated network. Based on the linkage control relationships set by this designated network, the fifth result can be configured as a trigger condition to initiate corresponding control actions, while the electronic device **200**'s display interface will show the representation of the fifth result for user viewing.
[0413] Optionally, the communication module **5** is further configured to execute a command from an application program to change the specified boundary.
[0414] Optionally, the communication module **5** is further configured to report the sensing result via the designated network in a state of being connected to the designated network, so that a gateway device and/or a cloud server **300** connected to the designated network can receive the sensing result and control a defined control result to be executed according to a target control relationship matching the sensing result in at least one pre-set control relationship; wherein the control relationship defines a mapping relationship between at least one of a plurality of sensing results and at least one control result; and the control result is an executable function of one controlled device connected to the designated network. Thus, based on the technical solution provided by this embodiment, the present invention can achieve diverse and complex intelligent linkage requirements by freely defining control relationships between various sensing results and executable functions of controlled devices connected to the designated network.
[0415] For example, a specific intelligent linkage application scenario is described as follows. The sensing module **31** of the microwave sensing apparatus is configured with a minimum sensing distance of 2 m and a maximum sensing distance of 4 m for the target sensing region, with the specified boundary set at a distance value of 2 m. Based on the designated network where the microwave sensing apparatus and electronic device **200** reside, the following control relationships are established. When the sensing result is “someone present”, it links to turn on Lamp 1. When it is “someone approaching”, it links to turn on Lamp 2 and turn off Lamp 1. When it is “someone departing”, it links to turn off Lamp 2 and turn on Lamp 1. Furthermore, based on this control relationship, the linkage effect of the intelligent scene that can be achieved is as follows. When a person walks from a direction away from the microwave sensing apparatus to a direction close to the microwave sensing apparatus, if the walking distance is within the range of 4 m, Lamp 1 will be

triggered to turn on. When it approaches and passes through the boundary of 2 m, Lamp 2 will be triggered to turn on and Lamp 1 will be triggered to turn off. When the walking distance is within the range of 2 m, the person will no longer be in the target sensing region. At this time, the sensing result in the target sensing region is “no human presence”, and the result of “no human presence” will be reported in a delayed manner so as to reduce the reported triggering event (if it is detected as “someone presence”, it will be reported immediately). When the person leaves, crossing the 2 m boundary while departing triggers Lamp 2 to turn off. Entering the 2-4 m range triggers Lamp 1 to turn on and turn off Lamp 1. This achieves intelligent linkage between lighting fixtures and the microwave sensing apparatus.

[0416] Optionally, the control result also includes changing the indication lamp signal of the microwave sensing apparatus. Thus, the microwave sensing apparatus can synchronize its own indication lamp signals while linking external electrical devices. For example, when detecting someone, it turns on corresponding lights and turns off its own indicator. When detecting no one, it turns off corresponding lights and turns on its own indication lamp, minimizing unnecessary activation of the device's indication lamp.

[0417] Optionally, referring to FIG. **15**, the microwave sensing apparatus further includes at least one switch module **34** for switching on/off a power supply circuit of an external electrical device. It is electrically connected to the communication module **5** to be switched on or off under the control of the communication module **5**. The communication module **5** is further configured to control the switch module **34** to switch on or off based on the sensing result according to a preset control logic, thereby controlling the power supply of the electrical device.

[0418] Optionally, the switch module **34** includes a relay electrically connected to the power supply circuit of an external electrical device to control the power supply of the electrical device to be turned on or off under the control of the communication module **5**.

[0419] Optionally, referring to FIG. **16**, the microwave sensing apparatus further includes a light sensing module **32** electrically connected to the communication module **5** for detecting illumination intensity.

[0420] Optionally, the communication module **5** is further configured to periodically acquire illumination intensity data via the light sensing module **32** and upload it, enabling the electronic device **200** to respond to the illumination intensity data and form a representation associated with it on the display interface thereof (refer to FIG. **17**). Thus, the communication module **5** can detect current illumination intensity via the light sensing module **32** and transmit the detected illumination intensity out to form the basis for setting trigger conditions in intelligent scenarios. In a specific example, the illumination intensity data from different time periods is fitted to form a fitting curve of the illumination intensity, allowing the users to intuitively view daily illumination intensity trends and facilitating reference for setting illumination intensity conditions when configuring intelligent scenarios.

[0421] Optionally, the communication module **5** is further configured to upload acquired illumination intensity data at predetermined intervals, or upload the acquired illumination intensity data when the change between two consecutive acquisitions exceeds a specified threshold, enabling the electronic device to respond to the illumination intensity data and form a representation associated with the illumination intensity data on the display interface thereof. Thus, based on this solution, the illumination intensity data is only reported when changes exceed a specified threshold or at predetermined intervals, not in real-time, significantly reducing data reporting when illumination intensity data changes are minimal.

[0422] Optionally, the communication module **5** is further configured to report the illumination intensity via the designated network when connected to it, enabling a gateway device and/or cloud server **300** connected to the designated network to receive the illumination intensity data and execute a defined control result according to a target control relationship matching the illumination intensity among at least one preset control relationship. The control relationship defines a mapping relationship between illumination intensity of at least one specified condition and at least one control result. The control result is an executable function of a controlled device connected to the designated network. The control relationship and control result in this embodiment can be understood with reference to the above embodiment and are not detailed here. The difference is that the trigger condition for intelligent scenarios in this embodiment is illumination intensity. Users can set reasonable mapping relationships based on illumination intensity values from each time period in the fitting curve, ensuring that the control results are executed more appropriately.

[0423] Optionally, the microwave sensing apparatus further includes a light-emitting module **33** electrically connected to the communication module **5** to emit an indication signal indicating the working state of the microwave sensing apparatus under its control. The communication module **5** is further adapted to turn off the indication lamp in the light-emitting module **33** when acquiring illumination intensity data via the light sensing module **32**. In this embodiment, the light sensing module **32** collects illumination intensity data and the light-emitting module **33** illuminates the indication lamp at intervals to prevent the indication lamp from affecting the accuracy of illumination intensity data during collection.

[0424] Optionally, the light-emitting module **33** includes an indication lamp, and the control result also includes changing the signal emitted by the indication lamp, allowing the microwave sensing apparatus to link its own indication lamp signal while linking external electrical devices.

[0425] Optionally, the microwave sensing apparatus further includes at least one switch module **34** for switching on/off a power supply circuit of an external electrical device. It is electrically connected to the communication module **5** to be switched on or off under the control of the communication module **5**. The communication module **5** is further configured to control the switch module **34** to switch on or off based on the illumination intensity according to a preset control logic, thereby controlling the power supply of the electrical device.

[0426] Optionally, the switch module **34** includes a relay electrically connected to the power supply circuit of an external electrical device to control the power supply of the electrical device to be turned on or off under the control of the communication module **5**.

[0427] Optionally, the light sensing module **32** includes a visible light photoelectric probe and an infrared light photoelectric probe. The light sensing module is configured to obtain the illumination intensity by processing the illumination data of the visible light photoelectric probe and the illumination data acquired by the infrared light photoelectric probe with a preset algorithm.

[0428] Furthermore, it should be noted that the communication module **5** can access the designated network in multiple ways to establish a communication connection with the electronic device **200**. An embodiment of the present invention provides a preferred implementation. Specifically, in this embodiment, the communication module **5** is further adapted to enter a network configuration mode in response to a designated network configuration operation to send out a designated network configuration signal to the outside such that a networked device receiving the designated network configuration signal instructs the communication module **5** to connect to the designated network in response to the designated network configuration signal, thereby enabling the microwave sensing apparatus to establish a communication connection with at least one electronic device **200** having a display interface by the designated network in a state in which the communication module is connected to the designated network.

[0429] Optionally, the communication module **5** is specifically adapted to determine that the communication module **5** enters a network configuration mode in response to at least one trigger signal generated by the specified network configuration operation in an unconfigured network mode, or to determine that the communication module **5** is reset to enter a network configuration mode in response to at least one trigger signal generated by the specified network configuration operation in a configured network mode.

[0430] In the network configuration mode, a network configuration message is generated and sent out, so that after receiving the network configuration message, the designated device instructs the

microwave sensing apparatus to join the designated network to complete the network configuration. The designated device includes an intelligent terminal device and/or a gateway device. After completing the network configuration, the microwave sensing apparatus can communicate with the gateway device by the designated network, and further communicate with the electronic device **200** connected to the designated network by the gateway.
[0431] Based on the above description, it should be understood that completing the network configuration mode should be understood as a mode in which the microwave sensing apparatus can perform data transmission with the gateway device after successfully joining the designated network. Furthermore, this embodiment provides a preferred implementation for the network configuration of the microwave sensing apparatus. Based on this implementation, the microwave sensing apparatus can be quickly discovered by intelligent terminal devices and/or gateway devices based on the network configuration message sent after entering the network configuration mode, and then instructed to join the designated network, thereby improving the network access efficiency of the microwave sensing apparatus. The instruction should include sending the name and password of an available network to the communication module **5**, so that the communication module **5** connects to the available network based on the name and password, thereby completing the relevant network configuration operations.
[0432] Optionally, the communication module **5** is also configured to control a light-emitting module **33** connected to the communication module **5** to emit a first prompt signal before sending the network configuration message, so as to prompt the user that the microwave sensing apparatus is about to enter the network configuration mode.
[0433] Optionally, during the network configuration, the communication module **5** is also configured to control a light-emitting module **33** connected to the communication module **5** to emit a second prompt signal. At least one of the following is different in the first prompt signal and the second prompt signal: [0434] flashing frequency; and [0435] color.
[0436] Thus, based on the technical solution provided in this embodiment, the user can easily distinguish the current state of the microwave sensing apparatus and confirm whether it has entered the network configuration mode based on the differences between the first prompt signal and the second prompt signal.
[0437] Optionally, the communication module **5** is further configured to:
[0438] periodically send reminder messages at predetermined intervals, thereby enabling the electronic device **200** to verify the online status of the microwave sensing apparatus upon receiving the reminder messages.
[0439] Optionally, the sensing module **31** specifically includes a radar module which forms an actual sensing region that can be covered by the detection wave by emitting the detection wave to the outside. The target sensing region is contained in the actual sensing region.
[0440] Optionally, the communication module **5** specifically includes a Bluetooth module, which establishes a communication relationship with the radar module via a serial port, establishes a communication relationship with the light sensing module **32** via IIC communication, and controls each indication lamp in the light-emitting module **33** via an input/output port.
[0441] Referring to FIG. **51**, a schematic flowchart of a microwave sensing method provided in this embodiment is shown, applied to a microwave sensing apparatus. The microwave sensing apparatus is adapted to establish a communication connection with an electronic device having a display interface by a designated network in a state in which the microwave sensing apparatus is communicatively connected to the designated network. The microwave sensing method includes:
[0442] S10, receiving and executing a selected instruction to change a sensing parameter; wherein the selected instruction is generated by the electronic device based on different selected operations performed on at least one representation associated with the sensing parameter displayed on the display interface thereof; [0443] S20, selecting at least one sub-sensing region based on the sensing parameters; wherein the sub-sensing region is associated with a target sensing region, enabling the

target sensing region to be dynamically formed based on different selected operations received by the electronic device; and [0444] S30, forming sensing results by detecting a moving human body within the target sensing region.

[0445] Optionally, the sensing parameter includes a maximum sensing distance value for defining a maximum sensing distance of a sub-sensing region. The selecting at least one sub-sensing region based on the sensing parameters specifically includes: [0446] changing the maximum sensing distance value based on a selected instruction, such that a maximum sensing distance of the target sensing region including the sub-sensing region can be flexibly set.

[0447] Optionally, the sensing parameter includes a minimum sensing distance value for defining a minimum sensing distance of a sub-sensing region. The selecting at least one sub-sensing region based on the sensing parameters specifically includes: [0448] changing the minimum sensing distance value based on a selected instruction, such that a minimum sensing distance of the target sensing region including the sub-sensing region can be flexibly set.

[0449] Optionally, the sensing parameters include at least one segment range starting from a first distance value and ending at a second distance value, for instructing the sensing module to divide a sub-sensing region having the first distance value as a minimum sensing distance value and the second distance value as a maximum sensing distance value; where the first distance value is less than the second distance value and greater than zero. The selecting at least one sub-sensing region based on the sensing parameters specifically includes: [0450] changing the first distance value and/or the second distance value based on a selected instruction, thereby varying a minimum sensing distance and/or maximum sensing distance of the target sensing region including the sub-sensing region.

[0451] Optionally, the sensing parameters include a plurality of sets of designated segment ranges, each segment range used to divide a sub-sensing region with the starting point of the segment range as the minimum sensing distance value and the ending point as the maximum sensing distance value. The selecting at least one sub-sensing region based on the sensing parameters specifically includes: [0452] selecting one or more sets of sub-sensing regions corresponding to the segment ranges pointed to by the selected instruction, enabling the target sensing region to be precisely set based on the selected different sub-sensing regions.

[0453] Optionally, a plurality of sets of designated segment ranges can form a complete range, the sets of segment ranges being mutually non-completely overlapping. The selecting at least one sub-sensing region based on the sensing parameters specifically includes selecting a plurality of non-overlapping segment ranges based on a selected instruction, enabling the target sensing region to be discontinuously combined by a plurality of discontinuous sub-sensing regions.

[0454] Optionally, after obtaining the sensing result, it further includes: [0455] sending a first result out, in a case that the sensing result within a specified time is the first result of a plurality of sensing results, to enable the electronic device to form a representation characterizing the first result on the display interface thereof in response to the first result; wherein the specified time is set by the electronic device according to a setting operation received by the display interface thereof; and the first result characterizes that no moving human body is detected within the target sensing region.

[0456] Optionally, when the sensing result is the first result of a plurality of sensing results, it further includes: [0457] calculating a duration time of a first result to form a fourth result sent out, such that the electronic device can form a representation characterizing the fourth result on the display interface thereof in response to the fourth result.

[0458] Optionally, the microwave sensing method further includes changing the specified time by executing commands from an application.

[0459] Optionally, after obtaining the sensing result, it further includes: [0460] immediately sending a second result out when the sensing result is a second result of a plurality of sensing results, to enable the electronic device to form a representation characterizing the second result on

the display interface thereof in response to the second result, wherein the second result characterizes that the moving human body is detected within the target sensing region.
[0461] Optionally, when the sensing result is the second result of a plurality of sensing results, it further includes: calculating a duration time of a second result to form a sixth result sent out, such that the electronic device can form a representation characterizing the sixth result on the display interface thereof in response to the sixth result.
[0462] Optionally, when the sensing result is the second result of a plurality of sensing results, it further includes, when the sensing result is the second result, emitting an indication signal according to specified rules.
[0463] Optionally, the indication signal of the specified pattern includes flashing a light signal of a specified color at a certain periodic frequency.
[0464] Optionally, after obtaining the second result, it further includes periodically sending a third result of the plurality of sensing results out, to enable the electronic device to form a representation characterizing the third result on the display interface thereof in response to the third result; wherein the third result characterizes the distance between the moving human body within the target sensing region and the microwave sensing apparatus.
[0465] Optionally, the obtaining the third result specifically includes: [0466] selecting a position parameter of a moving human body in the target sensing region, and forming a third result among the plurality of sensing results after processing the detected position parameter.
[0467] Optionally, after obtaining the third result, further including: [0468] judging the movement direction of the moving human body in the target sensing region based on the change trend of the third result within a specified time period; wherein the movement direction includes moving away and closer.
[0469] Optionally, the microwave sensing method further includes: [0470] setting a specified boundary, and determining whether the moving human body crosses the specified boundary according to the third result.
[0471] Optionally, after obtaining the sensing result, it further includes: [0472] sending a fifth result out when the sensing result is the fifth result of a plurality of sensing results, so as to enable the electronic device to form a representation characterizing the fifth result on the display interface thereof in response to the fifth result; the fifth result characterizes a moving human body within the target sensing region passing through a specified boundary within the target sensing region in a manner of moving closer and away.
[0473] Optionally, the microwave sensing method further includes changing the specified boundary by executing commands from an application.
[0474] Optionally, after obtaining the sensing result, further including: [0475] reporting the sensing result via the designated network in a state of being connected to the designated network, so that a gateway device and/or a cloud server connected to the designated network can receive the sensing result and control a defined control result to be executed according to a target control relationship matching the sensing result in at least one pre-set control relationship; wherein the control relationship defines a mapping relationship between at least one of a plurality of sensing results and at least one control result; and the control result is an executable function of one controlled device connected to the designated network.
[0476] Optionally, the control result also includes changing the indication lamp signal of the microwave sensing apparatus.
[0477] Optionally, after obtaining the sensing result, further including: [0478] controlling the power supply of an external electrical device based on the sensing results according to preset control logic.
[0479] Optionally, the controlling the power supply of an external electrical device based on the sensing results according to preset control logic specifically includes: [0480] controlling the power supply of the electrical device by turning on or off a relay connected to the power supply circuit of

the external electrical device.
[0481] Optionally, the microwave sensing method further includes: [0482] detecting illumination intensity within the target sensing region.
[0483] Optionally, after obtaining the illumination intensity, it further includes: [0484] uploading the illumination intensity data to enable the electronic device to form a representation associated with the illumination intensity data on the display interface thereof in response to receiving the illumination intensity data.
[0485] Optionally, the uploading the illumination intensity data specifically includes: [0486] uploading acquired illumination intensity data at predetermined intervals, or uploading the acquired illumination intensity data when the change between two consecutive acquisitions exceeds a specified threshold, enabling the electronic device to respond to the illumination intensity data and form a representation associated with the illumination intensity data on the display interface thereof.
[0487] Optionally, after obtaining the illumination intensity, the method further includes: [0488] reporting the illumination intensity via the designated network when connected to it, enabling a gateway device and/or cloud server connected to the designated network to receive the illumination intensity data and execute a defined control result according to a target control relationship matching the illumination intensity among at least one preset control relationship, wherein the control relationship defines a mapping relationship between illumination intensity of at least one specified condition and at least one control result; and the control result is an executable function of a controlled device connected to the designated network.
[0489] Optionally, when obtaining the illumination intensity, it further includes turning off the indication lamp.
[0490] Optionally, the control result further includes changing a signal emitted by the indication lamp.
[0491] Optionally, after obtaining the illumination intensity, the method further includes: [0492] controlling the power supply of an external electrical device based on the illumination intensity according to preset control logic.
[0493] Optionally, the controlling the power supply of an external electrical device based on the illumination intensity according to preset control logic specifically includes: [0494] controlling the power supply of the electrical device by turning on or off a relay connected to the power supply circuit of the external electrical device.
[0495] Optionally, the obtaining the illumination intensity specifically includes: [0496] obtaining the illumination intensity by processing illumination data acquired by a visible light photoelectric probe and illumination data acquired by an infrared light photoelectric probe with a preset algorithm.
[0497] Referring to FIG. **52**, an embodiment of the present invention further provides a microwave sensing apparatus **100**, including: [0498] the memory **101** configured to store code; and [0499] the processor **102** configured to execute the executable instructions to perform the methods mentioned above, particularly the operation process of the microwave sensing apparatus **100**.
[0500] The processor **102** can communicate with the memory **101** via a bus.
[0501] An embodiment of the present invention further provides a storage medium having stored thereon a program which, when executed by a processor, implements the methods mentioned above, particularly the operation process of the microwave sensing apparatus therein.
[0502] Those skilled in the art will understand that all or part of the steps for implementing the method embodiments described above may be completed by hardware related to program instructions. The aforementioned program may be stored in a computer-readable storage medium. The program, when executed, performs steps including the various method embodiments described above. The storage medium includes various media which can store program codes, such as ROM, RAM, magnetic or optical disks.

[0503] Referring to FIG. **53**, an embodiment of the present invention further provides a control system based on a microwave sensing apparatus, including the microwave sensing apparatus **100** mentioned above.
[0504] Further, in some embodiments, the control system further includes an intelligent terminal **400** and a gateway **500**.
[0505] The intelligent terminal **400** may be any device or combination of devices with data processing capability and external communication capability, such as a mobile phone, a computer, a tablet, a vehicle-mounted device, etc. The gateway **500** may be a gateway of any network, such as a WiFi network, a Zigbee network, or a Bluetooth network. In a further solution, the gateway may access the Internet to enable data exchange with other devices (e.g., intelligent terminals, speaker devices) connected to the Internet. Additionally, the gateway may be a dedicated gateway device or another device with gateway functionality (e.g., a speaker device with gateway functionality, a display device with gateway functionality, a computer with gateway functionality, a host, etc.).
[0506] The control system may further include a speaker device **600**, which may be any device with sound playback capability and may also have wired or wireless communication capability. In some solutions, the speaker device may be a smart voice speaker, which may also have voice recognition capability, protocol conversion capability, etc. In some solutions, the speaker device may achieve external communication by joining the gateway's network. In some solutions, it may also join the intelligent terminal's network (e.g., the terminal's WiFi hotspot or its connected network) for external communication. In some solutions, it may also achieve external communication by other means (e.g., joining other WiFi networks).
[0507] If the speaker device is a speaker device with gateway functionality, the speaker device may serve as the gateway, and the control system may include the speaker device with gateway functionality (which is also a gateway), without needing to configure both the speaker device and the gateway.
[0508] Thus, the gateway may be independent of the speaker device or may utilize the speaker device as the gateway.
[0509] The speaker device may also have Bluetooth communication capability, enabling it to communicate with terminals, gateways, etc., via Bluetooth when not with the network configuration. For example, during network configuration, it may send network configuration messages via Bluetooth, allowing the terminal or gateway to configure the network based on these messages and join it to a Bluetooth network or WiFi network.
[0510] In some solutions, the control system may further include a server. The microwave sensing apparatus, gateway, and intelligent terminal may all interact with the server, and data exchange between the gateway and intelligent terminal may be facilitated by the server. The speaker device may also interact with the server, enabling interaction with the terminal and/or gateway via the server. In some examples, the server may primarily serve as a data forwarder. In some examples, it may also handle data storage and processing.
[0511] In one implementation, if the gateway is a Bluetooth gateway and the corresponding network is a Bluetooth network (e.g., Bluetooth Mesh network), the microwave sensing apparatus may join the Bluetooth network after network configuration and communicate with the gateway (or a speaker device with gateway functionality) via Bluetooth signals. Simultaneously, the microwave sensing apparatus may also communicate with the intelligent terminal via Bluetooth signals, enabling the intelligent terminal (e.g., the aforementioned electronic device) to send messages to the microwave sensing apparatus (or the speaker device with gateway functionality) based on Bluetooth signals.
[0512] In the description of this description, references to terms such as “some embodiments” “a specific implementation” “a specific implementation process” or “an example” mean that the specific features, structures, materials, or characteristics described in connection with the embodiment or example are included in at least one embodiment or example of the present

invention. In this description, schematic expressions of the above terms corresponding to the described specific features, structures, materials, or characteristics may be combined in any suitable manner in any one or more embodiments or examples.
[0513] Additionally, it should be noted that the above embodiments may be combined with each other. For the same or similar concepts or processes, they may not be described in detail in some embodiments. That is, the technical solutions disclosed in subsequent embodiments (in the order of the text) should include the technical solutions described in those embodiments and all preceding embodiments.
[0514] Finally, it should be noted that the above embodiments are only intended to illustrate the technical solutions of the present invention, not to limit them. Although the present invention has been described in detail with reference to the foregoing embodiments, those skilled in the art will understand that they may still modify the technical solutions described in the foregoing embodiments or equivalently replace some or all of the technical features. Such modifications or replacements will not cause the essence of the corresponding technical solutions to depart from the scope of the embodiments of the present invention.

## Claims

**1**. A microwave sensing apparatus, comprising: a sensing module adapted to receive and execute a selected instruction to change a sensing parameter; wherein the sensing parameter is configured to select at least one sub-sensing region; a communication module adapted to generate the selected instruction in response to at least one trigger signal generated for at least one selected operation of an electronic device in a state of being communicatively connected to the electronic device, wherein the communication module is directly or indirectly electrically connected to the sensing module to send the selected instruction to the sensing module; wherein the sub-sensing region is associated with a target sensing region, so that the target sensing region is dynamically formed according to different selected operations received by the electronic device, and a moving object in the target sensing region is detected by the sensing module so as to form a sensing result.
**2**. The microwave sensing apparatus according to claim 1, wherein the sensing parameters comprise at least one segment range starting from a first distance value and ending at a second distance value, for instructing the sensing module to divide a sub-sensing region having the first distance value as a minimum sensing distance value and the second distance value as a maximum sensing distance value; wherein the first distance value is less than the second distance value and greater than zero; the communication module is further configured to enable the sensing module to vary the first distance value and/or the second distance value based on a selected instruction, thereby changing a minimum sensing distance and/or a maximum sensing distance of a target sensing region which comprises the sub-sensing region.
**3**. The microwave sensing apparatus according to claim 1, wherein the sensing parameters comprise a plurality of sets of designated segment ranges, wherein each of the segment ranges is configured to instruct the sensing module to divide a sub-sensing region having a minimum sensing distance value at a starting point of the segment range and a maximum sensing distance value at an ending point of the segment range; the communication module is further configured to enable the sensing module to select, based on a selected instruction, one or more sets of sub-sensing regions corresponding to the segment range to which the selected instruction is directed, so that the target sensing region is precisely set according to the different sub-sensing regions selected.
**4**. The microwave sensing apparatus according to claim 3, wherein the plurality of sets of designated segment ranges are combined to form a complete range, the sets of segment ranges being mutually non-completely overlapping; and the sensing module selects a plurality of non-overlapping segment ranges according to a selected instruction to enable the target sensing region to be discontinuously combined by a plurality of discontinuous sub-sensing regions.

**5**. The microwave sensing apparatus according to claim 1, wherein the communication module is adapted to establish a communication connection with an electronic device having a display interface by a designated network in a state of being communicatively connected to the designated network, thereby acquiring a selected instruction corresponding to the selected operation according to at least one different selected operation associated with a representation of the sensing parameter with respect to a display interface of the electronic device; the communication module is further adapted to, in a state of being communicatively connected to a designated network, be communicatively connected to a cloud server by the designated network, so as to be able to generate a corresponding selected instruction according to a control message issued by the cloud server; and the control messages are generated and uploaded by the electronic device based on different selected operations for which the display interface has at least one representation associated with the sensing parameter.
**6**. The microwave sensing apparatus according to claim 5, wherein the communication module is further configured to send a first result out, in a case that the sensing result within a specified time is the first result, to enable the electronic device to form a representation characterizing the first result on the display interface thereof in response to the first result; the specified time is set by the electronic device according to a setting operation received by the display interface thereof; the first result characterizes that no moving object is detected within the target sensing region.
**7**. The microwave sensing apparatus according to claim 6, wherein the communication module is further configured to execute a command from an application to change the specified time.
**8**. The microwave sensing apparatus according to claim 5, wherein the communication module is further configured to immediately send a second result out when the sensing result is the second result, to enable the electronic device to form a representation characterizing the second result on the display interface thereof in response to the second result; and the second result characterizes that the moving object is detected within the target sensing region.
**9**. The microwave sensing apparatus according to claim 5, wherein the communication module is further configured to send a fifth result out when the sensing result is the fifth result, so as to enable the electronic device to form a representation characterizing the fifth result on the display interface thereof in response to the fifth result; and the fifth result characterizes a moving object within the target sensing region passing through a specified boundary within the target sensing region in a manner of moving closer and away
**10**. The microwave sensing apparatus according to claim 9, wherein the communication module is further configured to execute a command from an application to change the specified boundary.
**11**. The microwave sensing apparatus according to claim 5, wherein the communication module is further configured to report the sensing result via the designated network in a state of being connected to the designated network, so that a gateway device and/or a cloud server connected to the designated network receives the sensing result and control a defined control result to be executed according to a target control relationship matching the sensing result in at least one pre-set control relationship; the control relationship defines a mapping relationship between at least one of a plurality of sensing results and at least one control result; and the control result is an executable function of at least one controlled device connected to the designated network.
**12**. The microwave sensing apparatus according to claim 5, wherein the communication module is further adapted to enter a network configuration mode in response to a designated network configuration operation to send out a designated network configuration signal such that a networked device receiving the designated network configuration signal instructs the communication module to connect to the designated network in response to the designated network configuration signal, so as to establish a communication connection with at least one electronic device having a display interface by the designated network in a state in which the communication module is connected to the designated network.
**13**. The microwave sensing apparatus according to claim 12, wherein the communication module is

specifically adapted to determine that the communication module enters a network configuration mode in response to at least one trigger signal generated by the specified network configuration operation in an unconfigured network mode, or to determine that the communication module is reset to enter a network configuration mode in response to at least one trigger signal generated by the specified network configuration operation in a configured network mode; in the network configuration mode, a network configuration message is generated and sent out, so that after receiving the network configuration message, the designated device instructs the microwave sensing apparatus to join the designated network to complete the network configuration; the designated device comprises an intelligent terminal device and/or a gateway device; wherein after completing the network configuration, the microwave sensing apparatus communicates with the gateway device by the designated network, and further communicate with the electronic device connected to the designated network by the gateway.

**14**. The microwave sensing apparatus according to claim 1, wherein the microwave sensing apparatus further comprises at least one switch module for switching on/off a power supply circuit of an external electrical device; the microwave sensing apparatus is electrically connected to the communication module to be switched on or off under the control of the communication module; and the communication module is further configured to control the switch module to switch on or off based on the sensing result according to a preset control logic, thereby controlling the power supply of the electrical device.

**15**. The microwave sensing apparatus according to claim 1, wherein the microwave sensing apparatus further comprises: a housing having a first wall, wherein a detection switch, the sensing module and the communication module are provided inside the housing; an optical transceiver provided on the first wall, so that the microwave sensing apparatus emits light in a first direction by the optical transceiver and receives light incident in a second direction; a light sensing module, which is provided corresponding to the optical transceiver, electrically connected to the communication module, and configured to receive light in the second direction to perform illumination intensity detection; and a light-emitting module provided corresponding to the optical transceiver and electrically connected to the communication module for emitting light in the first direction under the control of the communication module, so as to form an indication signal for indicating a working state of the microwave sensing apparatus.

**16**. The microwave sensing apparatus according to claim 15, wherein the optical transceiver comprises: a light-transmitting part comprising an indication region and a light sensing region, wherein the indication region is provided corresponding to the light-emitting module so that light in a first direction emitted by the light-emitting module is emitted out of the housing by the light-transmitting part; the light sensing region is provided corresponding to the light sensing module, so that light in a second direction outside the housing is incident into the housing by the light-transmitting part and received by the light sensing module; and an optical path channel configured to both emit light in the first direction and receive light in the second direction; wherein the indication region and the light sensing region are provided to coincide, and the light-emitting module and the light sensing module are provided adjacent to each other.

**17**. The microwave sensing apparatus according to claim 16, wherein the optical transceiver further comprises a trigger part displaced relative to the first wall in response to a first operating force and provided relative to the detection switch so as to trigger the detection switch in response to the displacement.

**18**. The microwave sensing apparatus according to claim 15, wherein the microwave sensing apparatus further comprises a mounting bracket connected to the housing for fixedly mounting the housing to a mounting surface; and the mounting bracket is configured to adjust angles in at least two degrees of freedom and drive the housing to move so as to change the actual sensing region of the sensing module.

**19**. The microwave sensing apparatus according to claim 15, wherein the sensing module specifically comprises a radar module which forms an actual sensing region that is covered by the detection wave by emitting the detection wave to the outside; the target sensing region is contained in the actual sensing region; and the communication module specifically comprises a Bluetooth module, wherein the Bluetooth module establishes a communication relationship with the radar module via a serial port, establishes a communication relationship with the light sensing module via IIC communication, controls each indication lamp in the light-emitting module to emit light via an input/output port, and establishes a communication connection with the electronic device by joining a designated network composed of a gateway.

**20**. A control system based on a microwave sensing apparatus, comprising the microwave sensing apparatus according to claim 1; and at least one controlled device, wherein the controlled device is electrically connected to the microwave sensing apparatus corresponding thereto; and the working state of the controlled device is switched according to a sensing result transmitted by the microwave sensing apparatus.