TITLE OF THE INVENTION

COMMUNICATION DEVICE, COMMUNICATION METHOD, AND PROGRAM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001]

This application is based on Japanese Patent Application No. 2024-026993 filed on February 26, 2024, and a description thereof is incorporated herein by reference.

TECHNICAL FIELD

[0002]

The present disclosure relates to a communication device, a communication method, and a program.

BACKGROUND ART

[0003]

IEEE 802.11s is known, for example, as a route construction technique in a wireless multi-hop network (for example, Patent Literature 1). By using IEEE 802.11s, communication devices can be connected to each other to constitute a wireless multi-hop network.

CITATION LIST

Patent Literature

[0004]

Patent Literature1: Japanese Patent Application Publication No. 2008-124813

SUMMARY OF INVENTION

[0005]

Since a wireless multi-hop network uses radio waves, it is important to install relay devices at suitable locations in consideration of radio signal strength in order to perform stable communication. Therefore, when determining installation locations for relay devices, it has been necessary to first design a radio-base-station placement on paper in consideration of radio signal strength, measure radio signal strength using dedicated equipment before installation, and determine actual installation locations. However, there was a problem that consideration of radio signal strength on paper and use of dedicated equipment are troublesome and require specialized knowledge.

[0006]

Accordingly, an object of the present disclosure is to provide a technique that makes it possible to more easily determine installation locations for communication devices that perform wireless multistage relay.

[0007]

A communication device according to an aspect of the present disclosure is a communication device in a communication system supporting a wireless multi-hop network, comprising: a communication unit configured to receive a wireless signal transmitted from another communication device; a determination unit configured to determine, on the basis of radio signal strength of the wireless signal received by the communication unit, whether or not the other communication device is to be a target for route construction in the wireless multi-hop network; and an output unit configured to cause a light-emitting source to emit light on the basis of the radio signal strength.

Effects of Invention

[0008]

According to the present disclosure, it is possible to provide a technique that makes it possible to more easily determine installation locations for communication devices that perform wireless multistage relay.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

［FIG. 1] FIG. 1 is a diagram illustrating an example of a system configuration of a wireless communication system according to an embodiment.

[FIG. 2] FIG.2 is a diagram illustrating an example of a hardware configuration of a relay device.

[FIG. 3] FIG. 3 is a diagram illustrating another example of a hardware configuration of a relay device.

[FIG. 4] FIG. 4 is a diagram illustrating an example of a configuration of an input/output device.

[FIG. 5] FIG. 5 is a diagram illustrating an example of a functional block configuration of a relay device.

[FIG. 6] FIG. 6 is a flowchart illustrating an example of a processing procedure performed by a relay device.

[FIG. 7] FIG. 7 is a diagram illustrating an example of a light-emission method of a light-emitting source.

[FIG. 8] FIG. 8 is a diagram for explaining an example of visualizing wireless signals and the like.

DETAILED DESCRIPTION OF EMBODIMENTS

[0010]

A embodiment of the present disclosure will be described while referring to the attached drawings. Note that in the drawings, components with the same symbol have the same or a similar configuration.

[0011]

System Configuration

FIG. 1 is a diagram illustrating an example of a system configuration of a wireless communication system 1 according to an embodiment. The wireless communication system 1 supports a wireless multi-hop network and includes relay devices 10-1A to 10-1F, which are fixed stations, and relay devices 10-2A and 10-2B, which are mobile stations. The relay devices 10-1A to 10-1F, which are fixed stations, are referred to as "relay device (fixed station) 10-1" when not particularly distinguished from each other. The relay devices 10-2A and 10-2B, which are mobile stations, are referred to as "relay device (mobile station) 10-2" when not particularly distinguished from each other. Further, the relay device (fixed station) 10-1 and the relay device (mobile station) 10-2 are referred to as "relay device 10" when not distinguished from each other. The numbers of relay devices (fixed stations) 10-1 and relay devices (mobile stations) 10-2 included in the wireless communication system 1 are arbitrary and are not particularly limited. Further, the relay device 10 may be referred to as a wireless relay device, a relay device, or a communication device.

[0012]

The relay device (fixed station) 10-1 is intended to be a relay device 10 that basically does not move and is fixedly installed inside a building, outdoors, or the like. Further, the relay device (mobile station) 10-2 is intended to be a relay device 10 that is basically expected to move, for example, by being mounted on an automobile or carried by a user.

[0013]

Since the relay device (fixed station) 10-1A is connected to an external network 30 such as the Internet, it is referred to as a parent device, a parent station, or a root node. On the other hand, the relay devices (fixed stations) 10-1 other than the relay device (fixed station) 10-1A are referred to as child devices, child stations, or nodes because they are connected to other relay devices (fixed stations) 10-1 including the relay device (fixed station) 10-1A.

[0014]

The relay device 10 operates as an access point and can communicate with a terminal 20 via a wireless LAN, LPWA (Low-Power Wide-Area Network), Bluetooth (registered trademark), a wired LAN, or the like. The terminal 20 is, for example, a smartphone, a tablet terminal, a mobile phone, a personal computer (PC), a notebook PC, a personal digital assistant (PDA), a home game device, or the like. In the example of FIG. 1, the terminal 20A communicates with the relay device (mobile station) 10-2A, and the terminal 20B communicates with the relay device (mobile station) 10-2B. FIG. 1 is merely an example, and the terminal 20 can also communicate with the relay device (fixed station) 10-1.

[0015]

Further, the relay device 10 constitutes a wireless multi-hop network in accordance with an arbitrary protocol and performs wireless multistage relay. For example, the relay device 10 may construct routes in accordance with procedures specified in IEEE 802.11s, thereby causing the wireless communication system 1 as a whole to constitute a wireless multi-hop network. In IEEE 802.11s, communication routes are constructed on the basis of weight values, referred to as metrics, indicating costs for respective routes between relay devices 10. The relay device 10 may use any protocol as long as the protocol can realize a wireless multi-hop network.

[0016]

In the present embodiment, the relay device 10 performs route construction for a wireless multi-hop network on the basis of radio signal strength of a wireless signal transmitted from another relay device 10. For example, the relay device 10 that is a parent device transmits (broadcasts) a route constructing frame having a metric value of 0. Next, a nearby relay device 10 calculates a metric value (hereinafter referred to as an "cumulative metric value") obtained by adding the metric value included in the received route constructing frame and a metric value based on radio signal strength of the route constructing frame received from the relay device 10 that transmitted the route constructing frame.

[0017]

A metric value indicates a cost in a communication route. Therefore, the cumulative metric value may also be said to indicate a total cost in a route from the relay device 10 that is a parent device in a wireless mesh network.

[0018]

In the present embodiment, as an index indicating radio signal strength, an index representing received power (RSRP (Reference Signal Received Power)), an index indicating received

signal strength (RSSI (Received Signal Strength Indicator)), or SNR (Signal to Noise Ratio) may be used.

[0019]

Here, since the relay device (mobile station) 10-2 is expected to move, if the relay device (mobile station) 10-2 is included at an intermediate point in a route, the route may be switched frequently. If such switching of routes occurs at various locations in the wireless multi-hop network, communication quality of the entire network deteriorates, which is undesirable. Therefore, in the present embodiment, the relay device (mobile station) 10-2 may be configured not to transmit a route constructing frame. Further, the relay device (fixed station) 10-1 may be configured to transmit a route constructing frame. This makes it possible to prevent the relay device (mobile station) 10-2 from being present at an intermediate point in a route (in the example of FIG. 1, relay devices 10-1B, 10-1D, and 10-1E).

[0020]

The relay device 10 may use IEEE 802.11ax as a communication standard used with another relay device 10. The communicable distance of IEEE 802.11ax is approximately 200 m at maximum, and the transmission speed when the distance between devices is approximately 200 m is approximately 100 Mbps. Further, the transmission speed gradually decreases as the number of relay stages increases. Use of IEEE 802.11ax is not essential, and another communication standard may be used.

[0021]

Further, the relay device (mobile station) 10-2 may use IEEE 802.11ah as a communication standard used with the terminal 20. IEEE 802.11ah is an unlicensed communication scheme, uses the 920 MHz band, has a communicable distance of approximately 1 km in radius, and has a communication speed of 20 Mbps at maximum. Further, it uses standard protocols used on the Internet. Use of IEEE 802.11ah is not essential, and another communication standard may be used.

[0022]

The wireless communication system 1 may use the large communication bandwidth (high-speed communication) of IEEE 802.11ax for communication between relay devices 10 and may use the long-distance transmission of IEEE 802.11ah for communication between the relay device (mobile station) 10-2 and the terminal 20. This makes it possible to realize monitoring and sensing over wide areas such as farms and factories, inventory management using RFID (Radio Frequency Identification), radio wave monitoring using a wideband reception module, and the like.

[0023]

In the present embodiment, the relay device 10 measures radio signal strength of radio waves received from another relay device 10 and visually displays a communication state by causing a light-emitting source to emit light on the basis of at least the radio signal strength. For example, the relay device 10 measures radio signal strength (signal strength of radio waves) of radio waves received from another relay device 10 connected to the relay device 10, and visually displays the communication state by changing at least a color of light, an intensity of light, and/or a flashing interval of light in accordance with the radio signal strength, using a light-emitting source connected to an input/output device mounted on the relay device 10.

[0024]

For example, when radio signal strength is visually displayed by a color of light, the color of light may be changed in accordance with radio signal strength, such that the color is green when the radio signal strength is equal to or greater than -70 dBm, orange when the radio signal strength is less than -70 dBm and equal to or greater than -75 dBm, red when the radio signal strength is less than -75 dBm, and turned off when the radio signal strength is so low that wireless relaying cannot be performed.

[0025]

Further, when radio signal strength is visually displayed by an intensity of light, for example, the intensity of light may be changed in accordance with radio signal strength, such that the intensity of light is high when the radio signal strength is high and the intensity of light is low when the radio signal strength is low. Further, when radio signal strength is visually displayed by a flashing interval of light, the flashing interval of light may be changed in accordance with radio signal strength, such that the flashing speed of light is fast when the radio signal strength is high and the flashing speed of light is slow when the radio signal strength is low. A user installing the relay device 10 can construct an optimal wireless mesh network by installing the relay device 10 at a position at which the communication state is optimal while checking, for example, the color of light. Further, even after the relay device 10 has once been installed, it is possible to determine whether it is better to change the installation position by remotely checking the color of light and the like. This eliminates the need to use dedicated equipment when installing the relay device 10 or the like and enables installation of the relay device 10 in consideration of an optimal communication state even without specialized knowledge.

[0026]

Hereinafter, the relay device 10 will be described on the premise that a light-emitting source is caused to emit light on the basis of radio signal strength, but the present embodiment is not

limited thereto. The present embodiment is also applicable to a case where a communication state is visually displayed by causing a light-emitting source to emit light on the basis of a plurality of pieces of information including radio signal strength.

[0027]

Hardware Configuration

FIG. 2 is a diagram illustrating an example of a hardware configuration of the relay device 10. The relay device 10 includes a processor 11 such as a CPU (Central Processing Unit) or a GPU (Graphics Processing Unit), a storage device 12 such as a memory (for example, a RAM (Random Access Memory) or a ROM (Read Only Memory)), an HDD (Hard Disk Drive), and/or an SSD (Solid State Drive), a communication IF (Interface) 13 for performing wired or wireless communication, and an input/output device 14 for accepting various inputs and outputs. The input/output device 14 is mounted on a substrate of the relay device. The light-emitting source 15 is connected to the input/output device 14.

[0028]

As the light-emitting source 15, a self-luminous device such as a light bulb, an LED, a laser beam, or an electroluminescence (EL) panel can be used. Further, the light-emitting source 15 may use a backlight of a display device, such as a liquid crystal module or an LED display panel, a display light-emitting element, or the like.

[0029]

FIG. 3 is a diagram illustrating another example of a hardware configuration of the relay device 10. The relay device 10 illustrated in FIG. 3 includes a USB (Universal Serial Bus) port 16, and the input/output device 14 is connected to the relay device 10 via a USB cable inserted into the USB port 16. Aspects not particularly mentioned are the same as those in FIG. 2. The input/output device 14 may be connected to the relay device 10 using GPIO (General-purpose input/output) instead of the USB port 16 and the USB cable, or may be connected to the relay device 10 by a wireless transmission path such as a wireless LAN or Bluetooth.

[0030]

FIG. 4 is a diagram illustrating an example of a configuration of the input/output device 14. The configuration of the input/output device 14 illustrated in FIG. 4 is applicable to the input/output devices 14 illustrated in FIGS. 2 and 3. As illustrated in A of FIG. 4, the input/output device 14 may include an LED output device 14-1. Further, as illustrated in B of FIG. 4, the input/output device 14 may include the LED output device 14-1, a signal input device 14-2, and a signal output device 14-3. The signal input device 14-2 accepts input of a contact signal, a digital signal, or an analog signal to be transmitted to another relay device 10

or terminal 20. Further, the signal output device 14-3 outputs a contact signal, a digital signal, or an analog signal received from another relay device 10 or terminal 20. A digital signal or analog signal input to the signal input device 14-2 is transmitted to another relay device 10 through wireless multistage relay and is output from the signal output device 14-3 included in the other relay device 10.

[0031]

Functional Block Configuration

FIG. 5 is a diagram illustrating an example of a functional block configuration of the relay device 10. The relay device 10 includes a storage unit 100, a communication unit 101, a measurement unit 102, a determination unit 103, and an output unit 104. The storage unit 100 can be realized using the storage device 12 included in the relay device 10. Further, the communication unit 101, the measurement unit 102, the determination unit 103, and the output unit 104 can be realized by the processor 11 of the relay device 10 executing a program stored in the storage device 12. Further, the program can be stored in a storage medium. The storage medium storing the program may be a computer-readable non-transitory storage medium (Non-transitory computer-readable medium). The non-transitory storage medium is not particularly limited and may be, for example, a storage medium such as a USB (Universal Serial Bus) memory or a CD-ROM (Compact Disc Read-Only Memory).

[0032]

The storage unit 100 stores network configuration information indicating a connection configuration between relay devices 10 in a wireless multi-hop network. The network configuration information includes, for example, an identifier of a relay device 10 at an upper level (that is, on the parent device side) in the wireless multi-hop network and an identifier of a relay device 10 at a lower level (that is, on the side opposite to the parent device) in the wireless multi-hop network. Further, the storage unit 100 stores a cumulative metric value. The cumulative metric value may be included in the network configuration information.

[0033]

The communication unit 101 receives a wireless signal transmitted from another relay device 10. Further, the communication unit 101 transmits a wireless signal to another relay device 10. Further, the communication unit 101 may receive a route constructing frame (for example, a broadcast signal) transmitted from another relay device 10. Further, when the communication unit 101 receives a route constructing frame having a sequence number different from that of a previously received route constructing frame, the communication unit 101 may update the

cumulative metric value stored in the storage unit 100 to an initial value (a maximum value that the cumulative metric value can take).

[0034]

Further, when the relay device 10 operates as a fixed station, the communication unit 101 may communicate with another relay device 10 using IEEE 802.11ax, and, when the relay device 10 operates as a mobile station, the communication unit 101 may communicate with the terminal 20 using IEEE 802.11ah.

[0035]

The measurement unit 102 measures radio signal strength of a wireless signal received by the communication unit 101 from another relay device 10. The wireless signal for which radio signal strength is measured may be a route constructing frame or a predetermined reference signal.

[0036]

The determination unit 103 determines, on the basis of radio signal strength of a wireless signal received by the communication unit 101, whether or not another relay device 10 is to be a target for route construction in the wireless multi-hop network. For example, when wireless signals are received from a plurality of relay devices 10, the determination unit 103 may set, as a target for route construction in the wireless multi-hop network, a relay device 10 having radio signal strength equal to or greater than a predetermined threshold and having greater radio signal strength.

[0037]

The output unit 104 causes the light-emitting source 15 to emit light on the basis of the radio signal strength measured by the measurement unit 102.

[0038]

Processing Procedure

FIG. 6 is a flowchart illustrating an example of a processing procedure performed by the relay device 10.

[0039]

In step S10, the measurement unit 102 measures radio signal strength of a wireless signal transmitted from another relay device 10 and received by the communication unit 101. The radio signal strength to be measured may be an index representing received power (RSRP), an index indicating received signal strength (RSSI), or a signal-to-noise ratio (SNR).

[0040]

In step S11, the output unit 104 causes the light-emitting source 15 to emit light on the basis of the radio signal strength measured in step S10.

[0041]

Here, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to a first state when the measured radio signal strength is equal to or greater than a first threshold. Further, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to a second state when the radio signal strength is less than the first threshold and equal to or greater than a second threshold. Further, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to a third state when the radio signal strength is less than the second threshold and equal to or greater than a third threshold. Further, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to a fourth state when the radio signal strength is less than the third threshold. The first threshold is a value greater than the second threshold, the second threshold is a value greater than the third threshold, and the third threshold is a value greater than a fourth threshold.

[0042]

Further, the first state may mean a state in which the radio wave condition is good (for example, a state in which the INDICATOR in FIG. 7 is green), the second state may mean a state in which the radio wave condition is normal (for example, a state in which the INDICATOR in FIG. 7 is orange), the third state may mean a state in which the radio wave condition is poor (for example, a state in which the INDICATOR in FIG. 7 is red), and the fourth state may mean a state in which communication with the upstream (parent device-side) relay device 10 is not possible (for example, a state in which the INDICATOR in FIG. 7 is turned off).

[0043]

Further, the output unit 104 may change the light-emission method of the light-emitting source 15 depending on whether the relay device 10 is a parent device or a child device. For example, when the relay device 10 operates as a parent device, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to the first state. Further, when the relay device 10 operates as a child device and the measured radio signal strength is equal to or greater than the first threshold, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to the first state. Further, when the radio signal strength is less than the first threshold and equal to or greater than the second threshold, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to the second state. Further, when the radio signal strength is less than the second threshold and equal

to or greater than the third threshold, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to the third state. Further, when the radio signal strength is less than the third threshold, the output unit 104 may cause the light-emitting source 15 to emit light in a manner corresponding to the fourth state.

[0044]

FIG. 7 is a diagram illustrating an example of a light-emission method of the light-emitting source 15. There may be a plurality of light-emitting sources. In the example of FIG. 7, the relay device 10 includes five light-emitting sources 15, namely, POWER, STATUS, 2.4GHz communication, INDICATOR, and OPRERATION. "INDICATOR" indicates a wireless communication state between the relay device 10 and another relay device 10. Further, "OPERATION" indicates whether the relay device 10 is operating as a parent device or as a child device.

[0045]

Further, the output unit 104 may calculate radio signal strength of a wireless signal received by the communication unit 101 by adding, at a predetermined ratio, radio signal strength of a wireless signal received in the past and radio signal strength of a newly received wireless signal, and may cause the light-emitting source to emit light on the basis of the calculated radio signal strength. Specifically, rather than causing the light-emitting source 15 to emit light using the received radio signal strength of the wireless signal as it is, the output unit 104 may cause the light-emitting source 15 to emit light on the basis of radio signal strength averaged by using a first-order filter or the like.

[0046]

For example, an averaged radio signal strength Pave may be calculated using the following equation, where an averaged radio signal strength is Pave_old, the measured radio signal strength is Pnow, and the averaging number is N.

[0047]

$$Pave = (Pave_old \times (N - 1) + Pnow) / N$$

Here, N can be set to any value. When N is set to a small value, the radio signal strength of a newly received wireless signal has a large influence, and thus this is suitable for an environment in which the radio signal strength fluctuates frequently. That is, this is suitable when the relay device 10 operates as a mobile station. Further, when N is set to a large value, the radio signal strength of a wireless signal received in the past has a large influence, and thus this can be

applied to stabilization of radio signal strength for a fixed station. That is, this is suitable when the relay device 10 operates as a fixed station.

[0048]

The output unit 104 is not limited to a first-order filter and may use another averaging method. For example, the output unit 104 may average values of radio signal strength for a predetermined number of past instances. By causing the light-emitting source 15 to emit light on the basis of the averaged radio signal strength, it becomes possible to stabilize the light-emission mode of the light-emitting source 15 even when changes in radio signal strength are frequent.

[0049]

In step S12, the relay device 10 ends the processing when light emission is to be stopped (for example, when the power of the relay device 10 is turned off). When light emission is to be continued, the process returns to the processing procedure of step S10, and measurement of radio signal strength and light emission by the light-emitting source 15 are repeated.

[0050]

Additional Information

FIG. 8 is a diagram for explaining an example of visualizing a wireless signal and the like. As illustrated in FIG. 8, the output unit 104 may cause the light-emitting source 15 to emit light on the basis of information other than radio signal strength. The light-emitting source 15 of the relay device 10 includes a plurality of light-emitting sources, and a light-emitting source that emits light on the basis of at least radio signal strength and a light-emitting source that emits light on the basis of information other than radio signal strength may be different from each other.

[0051]

For example, the output unit 104 may cause the light-emitting source 15 to emit light when detecting an improperly installed communication device (for example, a spoofed AP (Access Point)). For example, when detecting a wireless signal from a communication device (for example, an AP or the relay device 10) having a MAC address other than a MAC address registered in the relay device 10 itself, the output unit 104 may determine that an improperly installed communication device exists and cause the light-emitting source 15 to emit light.

[0052]

Further, the output unit 104 may cause the light-emitting source 15 to emit light on the basis of a usage status of the wireless multi-hop network. For example, the output unit 104 may cause the light-emitting source 15 to emit light in a color or the like corresponding to an amount of

communication with another relay device 10. This makes it possible for an administrator or the like of the relay device 10 to ascertain the usage status of the wireless multi-hop network remotely.

[0053]

Further, the output unit 104 may cause the light-emitting source 15 to emit light on the basis of the number of accesses and/or access communication capacity. For example, the output unit 104 may cause the light-emitting source 15 to emit light in a color or the like corresponding to the number of one or more terminals 20 that access (communicate with) an access point included in the relay device 10. Further, the output unit 104 may cause the light-emitting source 15 to emit light in a color or the like corresponding to an amount of data transmitted and received with one or more terminals 20 that access (communicate with) an access point included in the relay device 10. This makes it possible for an administrator or the like of the relay device 10 to ascertain remotely a load state of the access point function included in the relay device 10.

[0054]

Further, the output unit 104 may cause the light-emitting source 15 to emit light on the basis of a connection state of a communication line with an external network 30, such as the Internet, connected to the wireless multi-hop network. For example, when the communication line with the external network 30 is disconnected, the output unit 104 may output a notification indicating the disconnection. The output unit 104 may detect whether or not the communication line is disconnected on the basis of whether communication with a given device existing in the external network 30 is possible, and may change the color of the light-emitting source 15. This makes it possible for an administrator or the like of the relay device 10 to ascertain remotely the connection state with the external network 30.

[0055]

Further, when detecting radio waves of a given frequency transmitted from another communication device other than the relay device 10, the output unit 104 may cause the light-emitting source 15 to emit light on the basis of the presence or absence of the detected radio waves. The frequency of the radio waves to be detected may be specified in advance or may be arbitrarily specifiable. An external device (such as a dongle) capable of receiving radio waves of the frequency may be connected to the relay device 10 in order to detect radio waves of the frequency. For example, frequencies specified in advance include, for example, frequencies used for eavesdropping devices and frequencies used for drone operation. This

makes it possible for an administrator or the like of the relay device 10 to ascertain remotely that another communication device exists in the vicinity of the relay device 10 and the like.

[0056]

Further, the output unit 104 may cause the light-emitting source 15 to emit light on the basis of an output signal of a camera or sensor connected to the relay device 10. For example, a human presence sensor installed in a predetermined area may be connected to the relay device 10, and the output unit 104 may cause the light-emitting source 15 to emit light when the human presence sensor responds to a person. This makes it possible for an administrator or the like of the relay device 10 to ascertain remotely, for example, that a person has entered an area existing in the vicinity of the relay device 10.

[0057]

Summary

According to the embodiment described above, it is possible to provide a technique that makes it possible to more easily determine installation locations of communication devices that performs wireless multistage relay.

[0058]

The embodiment described above is intended to facilitate understanding of the present invention and is not intended to limit interpretation of the present invention. The flowcharts, sequences, respective elements included in the embodiment, and arrangements, materials, conditions, shapes, sizes, and the like thereof described in the embodiment are not limited to those illustrated and may be changed as appropriate. Further, configurations shown in different embodiments can be partially replaced with or combined with each other.

DESCRIPTION OF CODE

[0059]

1 ... Wireless communication system

10 ... Relay device

11 ... Processor

12 ... Storage device

14 ... Input/output device

14-1 ... LED output device

14-2 ... Signal input device

14-3 ... Signal output device

15 ... Light-emitting source

16 ... USB port

20 ... Terminal

30 ... External network

100 ... Storage unit

101 ... Communication unit

102 ... Measurement unit

103 ... Determination unit

104 ... Output unit

CLAIMS

1. A communication device in a communication system supporting a wireless multi-hop network, comprising:

a communication unit configured to receive a wireless signal transmitted from another communication device;

a determination unit configured to determine, on the basis of radio signal strength of the wireless signal received by the communication unit, whether or not the other communication device is to be a target for route construction in the wireless multi-hop network; and

an output unit configured to cause a light-emitting source to emit light on the basis of the radio signal strength.

2. The communication device according to claim 1, wherein the output unit is configured to: cause the light-emitting source to emit light in a manner corresponding to a first state when the radio signal strength is equal to or greater than a first threshold;

cause the light-emitting source to emit light in a manner corresponding to a second state when the radio signal strength is less than the first threshold and equal to or greater than a second threshold;

cause the light-emitting source to emit light in a manner corresponding to a third state when the radio signal strength is less than the second threshold and equal to or greater than a third threshold; and cause the light-emitting source to emit light in a manner corresponding to a fourth state when the radio signal strength is less than the third threshold.

3. The communication device according to claim 1, wherein the output unit is configured to: cause the light-emitting source to emit light in a manner corresponding to a first state when the communication device operates as a parent device; and

when the communication device operates as a child device,

cause the light-emitting source to emit light in a manner corresponding to the first state when the radio signal strength is equal to or greater than a first threshold,

cause the light-emitting source to emit light in a manner corresponding to a second state when the radio signal strength is less than the first threshold and equal to or greater than a second threshold,

cause the light-emitting source to emit light in a manner corresponding to a third state when the radio signal strength is less than the second threshold and equal to or greater than a third threshold, and

cause the light-emitting source to emit light in a manner corresponding to a fourth state when the radio signal strength is less than the third threshold.

4. The communication device according to claim 1, wherein the output unit is configured to calculate radio signal strength of the wireless signal received by the communication unit by adding, at a predetermined ratio, radio signal strength of a wireless signal received in the past and radio signal strength of a newly received wireless signal, and to cause the light-emitting source to emit light on the basis of the calculated radio signal strength.

5. The communication device according to claim 1, wherein the communication unit is configured to communicate with the other communication device using IEEE 802.11ax when the communication device operates as a fixed station, and to communicate with a terminal using IEEE 802.11ah when the communication device operates as a mobile station.

6. The communication device according to claim 1, wherein the output unit is configured to cause the light-emitting source to emit light on the basis of detection of an improperly installed communication device, an amount of communication between the communication device and another communication device, a number of one or more terminals accessing an access point included in the communication device, an amount of data transmitted and received between one or more terminals accessing the access point included in the communication device, a connection state of a communication line with an external network connected to the wireless multi-hop network, presence or absence of radio waves of a predetermined frequency transmitted from a communication device other than the communication device, and/or an output signal of a sensor connected to the communication device.

7. A communication method executed by a communication device in a communication system supporting a wireless multi-hop network, comprising:

receiving a wireless signal transmitted from another communication device;

determining, on the basis of radio signal strength of the received wireless signal, whether or not the other communication device is to be a target for route construction in the wireless multi-hop network; and

causing a light-emitting source to emit light on the basis of the radio signal strength.

8. A program for causing a communication device in a communication system supporting a wireless multi-hop network to execute:

receiving a wireless signal transmitted from another communication device;

determining, on the basis of radio signal strength of the received wireless signal, whether or not the other communication device is to be a target for route construction in the wireless multi-hop network; and

causing a light-emitting source to emit light on the basis of the radio signal strength.