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COMMUNICATION APPARATUS, COMMUNICATION METHOD, AND NON-TRANSITORY COMPUTER-READABLE STORAGE MEDIUM

Abstract

A communication apparatus comprises an obtaining unit configured to obtain information of a plurality of access points of different frequency bands; a change unit configured to compare a frequency band during connection and a frequency band of a roaming target, and change a roaming condition for executing roaming; and an execution unit configured to execute roaming in a case where a signal of the frequency band during connection satisfies the roaming condition.

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Background/Summary

BACKGROUND OF THE INVENTION
Field of the Invention
[0001] The present invention relates to a communication apparatus, a communication method, and a non-transitory computer-readable storage medium.
Description of the Related Art
[0002] There is known roaming of switching a communication apparatus between access points (to be referred to as APs hereinafter) of the same SSID. For roaming, a function activation condition is set. For example, when one of the signal-to-noise ratio (to be referred to as SNR hereinafter), the Received Signal Strength Indicator (to be referred to as RSSI hereinafter), and the like drops to be lower than a predetermined threshold, roaming is executed. The SNR is the ratio of a signal to noise. If the SNR is high, the influence of noise is small and the signal is strong, and if it is low, the influence of noise is large and the signal is weak. The RSSI is the indicator of the strength of a received signal. If the RSSI is high, the signal is strong, and if it is low, the signal is weak.
[0003] Japanese Patent Laid-Open No. 2014-232977 discloses a method of scanning the same band as the band of a currently connected AP channel as a scan band of high priority order, and when there is no roaming destination AP as the result of scan, scanning a band different from the band of the currently connected channel.
[0004] Japanese Patent Laid-Open No. 2023-72130 discloses a method of reading out roaming start conditions that associate position information of a mobile unit, direction information representing a direction in which the mobile unit enters a position represented by the position information, and an RSSI threshold, and setting an RSSI threshold based on the detected value of the position information of the mobile unit and that of the direction information of the mobile unit.
SUMMARY OF THE INVENTION
[0005] However, in the conventional techniques disclosed in the above-described patent literatures, the throughput after roaming may decrease as a result of roaming when the frequency band of a connected AP and that of a roaming destination AP are different in roaming. This is generally because the throughput is different depending on the frequency band.
[0006] The present invention provides a technique of reducing a decrease in throughput after roaming.
[0007] According to one aspect of the present disclosure, there is provided a communication apparatus comprising: an obtaining unit configured to obtain information of a plurality of access points of different frequency bands; a change unit configured to compare a frequency band during connection and a frequency band of a roaming target, and change a roaming condition for executing roaming; and an execution unit configured to execute roaming in a case where a signal of the frequency band during connection satisfies the roaming condition.
[0008] According to another aspect of the present disclosure, there is provided a communication method comprising: obtaining information of a plurality of access points of different frequency bands; comparing a frequency band during connection and a frequency band of a roaming target to change a roaming condition for executing roaming; and executing roaming in a case where a signal of the frequency band during connection satisfies the roaming condition.
[0009] According to another aspect of the present disclosure, there is provided a non-transitory computer-readable storage medium storing a computer program that, when read and executed by a computer, causes the computer to function as an obtaining unit configured to obtain information of a plurality of access points of different frequency bands; a change unit configured to compare a frequency band during connection and a frequency band of a roaming target, and change a roaming condition for executing roaming; and an execution unit configured to execute roaming in a case

where a signal of the frequency band during connection satisfies the roaming condition.
[0010] Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0011] FIG. **1**A is a block diagram showing the hardware arrangement of a digital camera **100**;
[0012] FIG. **1**B is a perspective front view of the digital camera **100**;
[0013] FIG. **1**C is a perspective rear view of the digital camera **100**;
[0014] FIG. **2**A is a view of a setup screen for setting communication;
[0015] FIG. **2**B is a view of a selection screen for selecting a network;
[0016] FIG. **2**C is a view of a completion screen showing the completion of connection;
[0017] FIG. **3** is a view showing a system configuration including the digital camera according to the embodiment;
[0018] FIG. **4** is a sequence chart showing processing between a digital camera and an AP according to the first embodiment;
[0019] FIG. **5** is a flowchart showing processing of the digital camera according to the first embodiment;
[0020] FIG. **6** is a sequence chart showing processing between a digital camera and an AP according to the second embodiment; and
[0021] FIGS. **7**A and **7**B is a flowchart showing processing of the digital camera according to the second embodiment.
DESCRIPTION OF THE EMBODIMENTS
[0022] Hereinafter, embodiments will be described in detail with reference to the attached drawings. Note, the following embodiments are not intended to limit the scope of the claimed invention. Multiple features are described in the embodiments, but limitation is not made to an invention that requires all such features, and multiple such features may be combined as appropriate. Furthermore, in the attached drawings, the same reference numerals are given to the same or similar configurations, and redundant description thereof is omitted.
Arrangement of Digital Camera
[0023] First, the arrangement and functions of a digital camera **100** according to an embodiment will be explained with reference to FIGS. **1**A to **1**C. FIGS. **1**A to **1**C are views showing the arrangement of the digital camera according to the embodiment. More specifically, FIG. **1**A is a block diagram showing the hardware arrangement of the digital camera **100**. FIG. **1**B is a perspective front view of the digital camera **100**. FIG. **1**C is a perspective rear view of the digital camera **100**.
[0024] Note that a digital camera capable of shooting a video (to be referred to as an image hereinafter) such as a still image or a moving image will be described as an example of a communication apparatus in the embodiment, but the application target of the embodiment is not limited to a digital camera. For example, the communication apparatus may be an information processing apparatus such as a tablet device or personal computer with a camera function, a surveillance camera, a medical camera, or the like. The digital camera **100** includes a control unit **101**, an image capturing unit **102**, a nonvolatile memory **103**, a working memory **104**, an operation unit **105**, a display unit **106**, a recording medium **107**, and a connection unit **108**.
[0025] The control unit **101** is an arithmetic processing device that comprehensively controls the whole digital camera **100**. The control unit **101** implements various processes such as communication processing and control processing (to be described later) by executing programs stored in the nonvolatile memory **103** (to be described later). The control unit **101** includes, for

example, a Central Processing Unit (CPU). Instead of or in addition to the CPU, the control unit **101** may include other processors such as a Micro Processing Unit (MPU), a Graphics Processing Unit (GPU), and a Quantum Processing Unit (QPU). Note that part or all of the apparatus may be controlled by sharing processing between one or a plurality of hardware units such as an Application Specific Integrated Circuit (ASIC), a Field Programmable Gate Array (FPGA), and the like, instead of controlling the overall apparatus by the control unit **101**.

[0026] The control unit **101** implements, for example, the functions of an obtaining unit, a change unit, and an execution unit by reading programs stored in the nonvolatile memory **103**. More specifically, the control unit **101** obtains information of a plurality of access points (to be referred to as APs hereinafter) of different frequency bands via the connection unit **108**. The control unit **101** compares a connected frequency band with a roaming target frequency band, and changes a roaming condition for executing roaming. When a signal of a connected frequency band satisfies the roaming condition, the control unit **101** executes roaming. Note that the contents of more detailed processing by the control unit **101** will be described later.

[0027] The image capturing unit **102** includes a lens group including a zoom lens and a focus lens, and a shutter having a stop function. The image capturing unit **102** includes an image sensor constituted by a Charge Coupled Device (CCD) or a Complementary Metal-Oxide-Semiconductor (CMOS) element, or the like that converts an object image into an electrical signal, and an A/D converter that converts an analog image signal output from the image sensor into a digital signal. Under the control of the control unit **101**, the image capturing unit **102** converts, into an electrical signal by the image sensor, object image light formed by a lens included in the image capturing unit **102**, performs noise reduction processing and the like, and outputs image data formed from a digital signal. The image data output from the image capturing unit **102** is recorded on, for example, the recording medium **107**.

[0028] The nonvolatile memory **103** is an electrically erasable and recordable memory, and for example, an Electrically Erasable Programmable Read-Only Memory (EEPROM) or the like is used. In the nonvolatile memory **103**, constants, programs, and the like for the operation of the control unit **101** are recorded. The programs here are programs for executing communication processing and control processing (to be described later) in the embodiment.

[0029] The working memory **104** temporarily stores programs and data. The working memory **104** is, for example, a Random Access Memory (RAM). The working memory **104** is used as a working area for deploying constants and variables for the operation of the control unit **101**, programs read out from the nonvolatile memory **103**, and the like. The working memory **104** is used as a buffer memory that temporarily holds image data captured by the image capturing unit **102**, and the image display memory of the display unit **106**.

[0030] The operation unit **105** includes operation members such as various switches, buttons, and a touch panel that accept various operations from a user. The operation unit **105** includes, for example, a shutter button **105***a*, a playback button **105***b*, a four-way key **105***c*, a touch panel **105***d*, and the like, as shown in FIGS. **1**B and **1**C. The shutter button **105***a* accepts an operation regarding shooting of an object. The playback button **105***b* accepts an operation regarding playback of a shot image. The four-way key **105***c* includes up, down, left, and right buttons, and accepts an operation regarding various settings of the camera. The touch panel **105***d* is formed integrally with the display unit **106** and accepts various operations.

[0031] The shutter button **105***a* is turned on by a so-called half stroke (shooting preparation instruction) during the operation, and generates the first shutter switch signal. Upon receiving the first shutter switch signal, the control unit **101** controls the image capturing unit **102** to start one of processes including auto focus (AF) processing, auto exposure (AE) processing, auto white balance (AWB) processing, and flash pre-emission (EF) processing, and the like. The shutter button **105***a* is turned on by a so-called full stroke (shooting instruction) upon completion of the operation, and generates the second shutter switch signal. Upon receiving the second shutter switch signal, the

control unit **101** starts a series of shooting processes from readout of a signal from the image capturing unit **102** to write of image data on the recording medium **107**.

[0032] The display unit **106** performs display of a viewfinder image at the time of shooting, display of a shot image, display of a text for an interactive operation, and the like. The display unit **106** is, for example, a display device such as a liquid crystal display or an organic EL display. The display unit **106** may be integrated with the digital camera **100** or be an external device connected to the digital camera **100**. The digital camera **100** suffices to be connectable to the display unit **106** and have a function of controlling display of the display unit **106**.

[0033] The recording medium **107** records, as an image file, image data output from the image capturing unit **102**. The control unit **101** reads out the image file recorded on the recording medium **107**. The recording medium **107** may be a memory card or hard disk drive attached to the digital camera **100**, or a flash memory or hard disk drive incorporated in the digital camera **100**. The digital camera **100** suffices to have a unit for accessing at least the recording medium **107**.

[0034] The connection unit **108** is an interface for connecting to an external device in a communication-enabling manner. The digital camera **100** according to the embodiment can exchange data with the external device via the connection unit **108**. For example, the digital camera **100** transmits, to the external device via the connection unit **108**, image data output from the image capturing unit **102**. The digital camera **100** can receive a control instruction output from the external device via the connection unit **108**. Note that in the embodiment, the connection unit **108** includes an interface for communicating with an external device via a wireless LAN in accordance with the IEEE 802.11 standards. The control unit **101** implements wireless communication with an external device by controlling the connection unit **108**.

Display Screen of Digital Camera

[0035] Next, the display screen of the digital camera **100** according to the embodiment will be explained with reference to FIGS. **2**A to **2**C. FIGS. **2**A to **2**C show the display screen of the digital camera. FIG. **2**A is a view of a setup screen for setting communication. FIG. **2**B is a view of a selection screen for selecting a network. FIG. **2**C is a view of a completion screen showing the completion of connection.

[0036] As shown in FIG. **2**A, a setup screen **200** includes a new setup button **201**, a cancel button **202**, and an OK button **203**. The setup screen **200** is a screen for setting connection with an external device such as an AP. The setup screen **200** is displayed on the display unit **106** of the digital camera **100**.

[0037] The new setup button **201** is a button for starting connection of the control unit **101** with an external device such as an AP.

[0038] The cancel button **202** is a button for canceling connection of the control unit **101** with an external device such as an AP.

[0039] The OK button **203** is a button for deciding the operation of the digital camera **100**. If the user selects the OK button **203** in a state in which the new setup button **201** is selected, the control unit **101** executes scan of an AP. In this scan, wireless reception of a signal including an SSID and a BSSID from one AP or each of a plurality of APs is tried.

[0040] As shown in FIG. **2**B, a selection screen **210** includes a connection button **211**, a connection button **212**, and a cancel button **213**. The selection screen **210** is a screen for selecting an external device such as an AP to be connected. The selection screen **210** is displayed on the display unit **106** of the digital camera **100**.

[0041] The connection button **211** is a button that allows a user to select an AP to which the digital camera **100** is connected. If the connection button **211** is selected, the control unit **101** executes a trial of connection to an AP based on a displayed SSID and ch. For example, when the connection button **211** is selected, the control unit **101** executes a trial of connection to an AP having an SSID “Conon” and a ch “1 ch”.

[0042] The connection button **212** is a button that allows a user to select an AP to which the digital

camera **100** is connected. If the connection button **212** is selected, the control unit **101** executes a trial of connection to an AP based on a displayed SSID and ch. For example, when the connection button **212** is selected, the control unit **101** executes a trial of connection to an AP having an SSID "Conon" and a ch "36 ch".

[0043] The cancel button **213** is a button that allows a user to cancel connection between the digital camera **100** and an external device such as an AP.

[0044] As shown in FIG. **2**C, a completion screen **220** includes an OK button **221**. The completion screen **220** is a screen displayed upon completion of connection between the digital camera **100** and an external device such as an AP. The completion screen **220** is displayed on the display unit **106** of the digital camera **100**.

[0045] The OK button **221** is a button for confirming the completion of connection with an external device by the digital camera **100**.

System Configuration Including Digital Camera

[0046] Next, a system configuration including the digital camera **100** according to the embodiment will be explained with reference to FIG. **3**. FIG. **3** is a view showing the system configuration including the digital camera **100**. The system includes the digital camera **100**, and APs **301** and **302** each serving as an external device that functions as an access point.

[0047] The digital camera **100** is set so that it can connect to the APs **301** and **302** having an SSID "Conon".

[0048] The AP **301** is set to the SSID "Conon" and a frequency band "2.4 GHz".

[0049] The AP **302** is set to the SSID "Conon" and a frequency band "6 GHz". That is, the frequency band of the AP **301** is different from that of the AP **302**.

First Embodiment

[0050] A roaming method according to the first embodiment will be explained with reference to FIGS. **4** and **5**.

Control Sequence of Digital Camera

[0051] The control sequence of a digital camera **100** according to the first embodiment will be explained with reference to FIG. **4**. FIG. **4** is a sequence chart showing processing between the digital camera and an AP according to the first embodiment.

[0052] In S**401**, a control unit **101** of the digital camera **100** accepts a connection start instruction from the user via an operation unit **105**. For example, in a state in which a setup screen **200** is displayed on a display unit **106**, as shown in FIG. **2**A, the control unit **101** accepts selection of a new setup button **201** by the user, and then accepts input of an OK button **203**. In response to this, the control unit **101** determines that the connection start instruction has been accepted.

[0053] In S**402**, the control unit **101** of the digital camera **100** performs scan to try wireless reception of a signal including an SSID and a BSSID from one AP or each of a plurality of APs.

[0054] In S**403**, the control unit **101** of the digital camera **100** accepts a connection AP selection instruction from the user via the operation unit **105**. For example, the control unit **101** accepts input of a connection button **211** in a state in which a selection screen **210** is displayed on the display unit **106**, as shown in FIG. **2**B.

[0055] In S**404**, the control unit **101** of the digital camera **100** associates, as the connection settings of the SSID and ch of a desired AP, the SSID and ch of an AP corresponding to the connection AP selection instruction accepted in S**403**, and stores them in a working memory **104**.

[0056] In S**405**, the control unit **101** of the digital camera **100** transmits a connection request to a connection trial target AP in order to perform connection processing in cooperation with the AP.

[0057] In S**406**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP.

[0058] In S**407**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is the desired AP, and establishes a wireless LAN connection with the AP. After establishing the wireless LAN connection, for example, the control unit **101** displays a completion

screen **220** on the display unit **106**, as shown in FIG. **2**C, and accepts input of an OK button **221** from the user. The control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP.

[0059] In S**408**, if the control unit **101** of the digital camera **100** determines that the SNR of the AP during connection (to be referred to as the connected AP hereinafter) becomes lower than an SNR threshold, it designates an AP of a desired SSID stored in the working memory **104** and performs scan. In the scan, the control unit **101** obtains the frequency band of the connected AP and that of a roaming target AP. Note that in the embodiment, the control unit **101** obtains the frequency band of the connected AP in S**408**, but can also obtain it in S**407** that is a timing when the digital camera **100** is connected to the connected AP.

[0060] In S**409**, the control unit **101** of the digital camera **100** determines whether the frequency band of the connected AP and that of the roaming target AP are different. If the control unit **101** determines that the frequency band of the connected AP and that of the roaming target AP are different, it changes the SNR threshold that is an SNR condition serving as a roaming condition. For example, when the frequency band of the connected AP is “2.4 GHz” and that of the roaming target AP is “6 GHz”, the control unit **101** determines that the frequency band of the roaming target AP is larger than that of the connected AP, and changes the SNR condition serving as a roaming condition, that is, the SNR threshold from originally set “15” to “20”. In other words, when the frequency band of the roaming target AP is larger than that of the connected AP, the control unit **101** relaxes the roaming condition to facilitate roaming. When the frequency band of the connected AP is “6 GHz” and that of the roaming target AP is “2.4 GHz”, the control unit **101** determines that the frequency band of the roaming target AP is smaller than that of the connected AP, and changes the SNR condition serving as a roaming condition, that is, the SNR threshold from originally set “15” to “10”. In other words, when the frequency band of the roaming target AP is smaller than that of the connected AP, the control unit **101** tightens the roaming condition to make roaming difficult.

[0061] In S**410**, if the control unit **101** of the digital camera **100** determines that the SNR of the connected AP is lower than the SNR threshold and the roaming condition is satisfied, it transmits a connection request to the connection trial target AP in order to perform connection processing in cooperation with the AP.

[0062] In S**411**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP.

[0063] In S**412**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is the desired AP, and establishes a wireless LAN connection with the AP. After establishing the wireless LAN connection, the control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP.

Control Procedure of Digital Camera

[0064] The control procedure of the digital camera **100** according to the first embodiment will be explained with reference to FIG. **5**. FIG. **5** is a flowchart showing processing of the digital camera according to the first embodiment.

[0065] In step S**501**, the control unit **101** of the digital camera **100** determines whether it has accepted a connection start instruction from the user. If the control unit **101** determines that it has accepted a connection start instruction, it advances the process to step S**502**. If the control unit **101** determines that it has not accepted a connection start instruction, it repeats the processing in step S**501**. The processing in step S**501** corresponds to S**401** in FIG. **4**.

[0066] In step S**502**, the control unit **101** of the digital camera **100** performs scan to try wireless reception of a signal including an SSID and a BSSID from one AP or each of a plurality of APs. The processing in step S**502** corresponds to S**402** in FIG. **4**.

[0067] In step S**503**, the control unit **101** of the digital camera **100** determines whether it has accepted a connection AP selection instruction. If the control unit **101** determines that it has accepted a connection AP selection instruction, it advances the process to step S**504**. If the control

unit **101** determines that it has not accepted a connection AP selection instruction, it repeats the processing in step S**503**.

[0068] In step S**504**, the control unit **101** of the digital camera **100** associates the SSID and ch of the AP included in the accepted connected AP selection instruction as the connection settings of the SSID and ch of a desired AP, and stores them in the working memory **104**. The processing in step S**504** corresponds to S**404** in FIG. **4**.

[0069] In step S**505**, the control unit **101** of the digital camera **100** transmits a connection request to a connection trial target AP in order to perform connection processing in cooperation with the AP. The processing in step S**505** corresponds to S**405** in FIG. **4**.

[0070] In step S**506**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP. The processing in step S**506** corresponds to S**406** in FIG. **4**.

[0071] In step S**507**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is the desired AP, and establishes a wireless LAN connection with the AP. After the establishment, the control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP. The processing in step S**507** corresponds to S**407** in FIG. **4**.

[0072] In step S**508**, the control unit **101** of the digital camera **100** determines whether a connection end instruction has been accepted from the user. If the control unit **101** determines that the connection end instruction has been accepted, it ends the process. If the control unit **101** determines that the connection end instruction has not been accepted, it advances the process to step S**509**.

[0073] In step S**509**, the control unit **101** of the digital camera **100** determines whether the SNR of the connected AP becomes lower than the SNR threshold. If the control unit **101** determines that the SNR of the connected AP becomes lower than the SNR threshold, it advances the process to step S**510**. If the control unit **101** determines that the SNR of the connected AP does not become lower than the SNR threshold, it returns to the processing in step S**508** to repeat the process from step S**508**.

[0074] In step S**510**, the control unit **101** of the digital camera **100** designates an AP of a desired SSID stored in the working memory **104** and performs scan. In the scan, the control unit **101** obtains the frequency band of the connected AP and that of a roaming target AP. The processing in step S**510** corresponds to S**408** in FIG. **4**.

[0075] In step S**511**, the control unit **101** of the digital camera **100** determines whether the frequency band of the roaming target AP is larger than that of the connected AP. If the control unit **101** determines that the frequency band of the roaming target AP is larger than that of the connected AP, it advances the process to step S**512**. If the control unit **101** determines that the frequency band of the roaming target AP is not larger than that of the connected AP, it advances the process to step S**513**.

[0076] In step S**512**, the control unit **101** of the digital camera **100** changes the SNR condition. The change of the SNR condition here is to increase the SNR threshold serving as a roaming condition. The processing in step S**512** corresponds to S**409** in FIG. **4**.

[0077] In step S**513**, the control unit **101** of the digital camera **100** changes the SNR condition. The change of the SNR condition here is to decrease the SNR threshold serving as a roaming condition. The processing in step S**513** corresponds to S**409** in FIG. **4**.

[0078] In step S**514**, the control unit **101** of the digital camera **100** determines, based on the SNR of the connected AP and the SNR threshold, whether the roaming condition is satisfied. If the SNR of the connected AP is lower than the SNR threshold, the control unit **101** determines that the roaming condition is satisfied, and advances the process to step S**515** to execute roaming. If the SNR of the connected AP is not lower than the SNR threshold, the control unit **101** determines that the roaming condition is not satisfied, and returns to the processing in step S**508** without

performing roaming.
[0079] In step S**515**, the control unit **101** of the digital camera **100** transmits a connection request to the connection trial target AP also serving as a roaming target in order to perform connection processing in cooperation with the AP. The processing in step S**515** corresponds to S**410** in FIG. **4**.
[0080] In step S**516**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP. The processing in step S**516** corresponds to S**411** in FIG. **4**.
[0081] In step S**517**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is the desired AP, and establishes a wireless LAN connection with the AP. After the establishment, the control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP. The processing in step S**517** corresponds to S**412** in FIG. **4**.
[0082] According to the first embodiment, the digital camera **100** obtains the frequency band of a connected AP and that of a roaming target AP. When the digital camera **100** determines that the frequency band of the roaming target AP is larger than that of the connected AP, it changes, to a large value, the SNR threshold that is an SNR condition serving as a roaming condition, so as to facilitate transfer. When the digital camera **100** determines that the roaming condition is satisfied, it executes roaming. According to the embodiment, a decrease in throughput after roaming can be reduced, and roaming can be easily performed to a frequency band of high throughput.

Second Embodiment

[0083] A roaming method according to the second embodiment will be explained with reference to FIGS. **6** and **7**.

Control Sequence of Digital Camera

[0084] The control sequence of a digital camera **100** according to the second embodiment will be explained with reference to FIG. **6**. FIG. **6** is a sequence chart showing processing between the digital camera and an AP according to the second embodiment.
[0085] In S**601**, a control unit **101** of the digital camera **100** accepts a connection start instruction from the user via an operation unit **105**. For example, in a state in which a setup screen **200** is displayed on a display unit **106**, as shown in FIG. **2**A, the control unit **101** accepts selection of a new setup button **201** by the user, and then accepts input of an OK button **203**. In response to this, the control unit **101** accepts the connection start instruction.
[0086] In S**602**, the control unit **101** of the digital camera **100** performs scan to try wireless reception of a signal including an SSID and a BSSID from one AP or each of a plurality of APs.
[0087] In S**603**, the control unit **101** of the digital camera **100** accepts a connection AP selection instruction from the user via the operation unit **105**. For example, the control unit **101** accepts input of a connection button **212** in a state in which a selection screen **210** is displayed on the display unit **106**, as shown in FIG. **2**B.
[0088] In S**604**, the control unit **101** of the digital camera **100** associates, as the connection settings of the SSID and ch of a desired AP, the SSID and ch of an AP corresponding to the connection AP selection instruction received in S**603**, and stores them in a working memory **104**.
[0089] In S**605**, the control unit **101** of the digital camera **100** transmits a connection request to a connection trial target AP in order to perform connection processing in cooperation with the AP.
[0090] In S**606**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP.
[0091] In S**607**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is the desired AP, and establishes a wireless LAN connection with the AP. After establishing the wireless LAN connection, for example, the control unit **101** displays a completion screen **220** on the display unit **106**, as shown in FIG. **2**C, and accepts input of an OK button **221** from the user. The control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP.

[0092] In S**608**, if the control unit **101** of the digital camera **100** determines that the RSSI of the connected AP becomes lower than an RSSI threshold and the lowering state continues for a communication deterioration determination time, it designates an AP of a desired SSID stored in the working memory **104** and performs scan. In the scan, the control unit **101** obtains the frequency band of the connected AP and that of a roaming target AP. For example, when the control unit **101** determines that the state in which the RSSI of the connected AP becomes lower than the RSSI threshold continues for a communication deterioration determination time "30 sec", it designates an AP having a desired SSID "Conon" stored in the working memory **104**, and performs scan. In the scan, the control unit **101** obtains the frequency band "2.4 GHz" of the connected AP and the frequency band "6 GHz" of the roaming target AP.

[0093] In S**609**, if the control unit **101** of the digital camera **100** determines that the frequency band of the connected AP and that of the roaming target AP are different, it changes the RSSI threshold that is an RSSI condition serving as a roaming condition. For example, when the frequency band of the connected AP is "6 GHz" and that of the roaming target AP is "2.4 GHz", the control unit **101** determines that the frequency band of the roaming target AP is smaller than that of the connected AP, and changes, from originally set "−50" to "−75", the RSSI threshold that is an RSSI condition serving as a roaming condition. In other words, when the frequency band of the roaming target AP is smaller than that of the connected AP, the control unit **101** tightens the roaming condition to make roaming difficult. When the frequency band of the connected AP is "2.4 GHz" and that of the roaming target AP is "6 GHz", the control unit **101** determines that the frequency band of the roaming target AP is larger than that of the connected AP, and changes the RSSI threshold serving as a roaming condition from originally set "−50" to "−25". In other words, when the frequency band of the roaming target AP is larger than that of the connected AP, the control unit **101** relaxes the roaming condition to facilitate roaming.

[0094] In S**610**, if the control unit **101** of the digital camera **100** determines that the frequency band of the roaming target AP is smaller than that of the connected AP, it changes the condition of the communication deterioration determination time serving as a roaming condition. For example, the control unit **101** changes, from originally set "30 sec" to "60 sec", the condition of the communication deterioration determination time serving as a roaming condition. In other words, when the frequency band of the roaming target AP is smaller than that of the connected AP, the control unit **101** makes roaming difficult.

[0095] In S**611**, if the control unit **101** of the digital camera **100** determines that the roaming condition is satisfied, it transmits a connection request to the connection trial target AP in order to perform connection processing in cooperation with the AP.

[0096] In S**612**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP.

[0097] In S**613**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is the desired AP, and establishes a wireless LAN connection with the AP. After establishing the wireless LAN connection, the control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP.

Control Procedure of Digital Camera

[0098] The control procedure of the digital camera **100** according to the second embodiment will be explained with reference to FIGS. **7**A and **7**B. FIGS. **7**A and **7**B are a flowchart showing processing of the digital camera according to the second embodiment.

[0099] In step S**701**, the control unit **101** of the digital camera **100** determines whether it has accepted a connection start instruction. If the control unit **101** determines that it has accepted a connection start instruction, it advances the process to step S**702**. If the control unit **101** determines that it has not accepted a connection start instruction, it repeats the processing in step S**701**. The processing in step S**701** corresponds to S**601** in FIG. **6**.

[0100] In step S**702**, the control unit **101** of the digital camera **100** performs scan to try wireless

reception of a signal including an SSID and a BSSID from one AP or each of a plurality of APs. The processing in step S**702** corresponds to S**602** in FIG. **6**.

[0101] In step S**703**, the control unit **101** of the digital camera **100** determines whether it has accepted a connection AP selection instruction. If the control unit **101** determines that it has accepted a connection AP selection instruction, it advances the process to step S**704**. If the control unit **101** determines that it has not accepted a connection AP selection instruction, it repeats the processing in step S**703**.

[0102] In step S**704**, the control unit **101** of the digital camera **100** associates an SSID and ch included in the received connected AP selection instruction as the connection settings of the SSID and ch of a desired AP, and stores them in the working memory **104**. The processing in step S**704** corresponds to S**604** in FIG. **6**.

[0103] In step S**705**, the control unit **101** of the digital camera **100** transmits a connection request to a connection trial target AP in order to perform connection processing in cooperation with the AP. The processing in step S**705** corresponds to S**605** in FIG. **6**.

[0104] In step S**706**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP. The processing in step S**706** corresponds to S**606** in FIG. **6**.

[0105] In step S**707**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is the desired AP, and establishes a wireless LAN connection with the AP. After the establishment, the control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP. The processing in step S**707** corresponds to S**607** in FIG. **6**.

[0106] In step S**708**, the control unit **101** of the digital camera **100** determines whether a connection end instruction has been accepted. If the control unit **101** determines that the connection end instruction has been accepted, it ends the process. If the control unit **101** determines that the connection end instruction has not been accepted, it advances the process to step S**709**.

[0107] In step S**709**, the control unit **101** of the digital camera **100** determines whether the RSSI of the connected AP becomes lower than the RSSI threshold. If the control unit **101** determines that the RSSI of the connected AP becomes lower than the RSSI threshold, it advances the process to step S**710**. If the control unit **101** determines that the RSSI of the connected AP does not become lower than the RSSI threshold, it returns to the processing in step S**708** to repeat the process from step S**708**.

[0108] In step S**710**, the control unit **101** of the digital camera **100** determines whether the time during which the RSSI of the connected AP becomes lower than the RSSI threshold becomes longer than the communication deterioration determination time. If the control unit **101** determines that the time during which the RSSI of the connected AP becomes lower than the RSSI threshold becomes longer than the communication deterioration determination time, it advances the process to step S**711**. If the control unit **101** determines that the time during which the RSSI of the connected AP becomes lower than the RSSI threshold does not become longer than the communication deterioration determination time, it returns to the processing in step S**708**.

[0109] In step S**711**, the control unit **101** of the digital camera **100** designates an AP of a desired SSID stored in the working memory **104** and performs scan. In the scan, the control unit **101** obtains the frequency band of the connected AP and that of a roaming target AP. The processing in step S**711** corresponds to S**608** in FIG. **6**.

[0110] In step S**712**, the control unit **101** of the digital camera **100** determines whether the frequency band of the roaming target AP is smaller than that of the connected AP. If the control unit **101** determines that the frequency band of the roaming target AP is smaller than that of the connected AP, it advances the process to step S**713**. If the control unit **101** determines that the frequency band of the roaming target AP is not smaller than that of the connected AP, it advances the process to step S**715**.

[0111] In step S**713**, the control unit **101** of the digital camera **100** changes the RSSI condition. The change of the RSSI condition here is to decrease the RSSI threshold serving as a roaming condition. The processing in step S**713** corresponds to S**609** in FIG. **6**.
[0112] In step S**714**, the control unit **101** of the digital camera **100** changes the time condition. The change of the time condition here is to prolong the communication deterioration determination time serving as a roaming condition. The processing in step S**714** corresponds to S**610** in FIG. **6**.
[0113] In step S**715**, the control unit **101** of the digital camera **100** changes the RSSI condition. The change of the RSSI condition here is to increase the RSSI threshold serving as a roaming condition. The processing in step S**713** corresponds to S**609** in FIG. **6**.
[0114] In step S**716**, the control unit **101** of the digital camera **100** changes the time condition. The change of the time condition here is to shorten the communication deterioration determination time serving as a roaming condition. The processing in step S**716** corresponds to S**610** in FIG. **6**.
[0115] In step S**717**, the control unit **101** of the digital camera **100** determines, based on the RSSI threshold and the communication deterioration determination time, whether the roaming condition is satisfied. If the control unit **101** determines that the roaming condition is satisfied, it advances the process to step S**718** to execute roaming. More specifically, when the RSSI of the connected AP becomes lower than the RSSI threshold and the lowering time becomes longer than the communication deterioration determination time, the control unit **101** determines that the roaming condition is satisfied. In contrast, if the control unit **101** determines that the roaming condition is not satisfied, it returns to the processing in step S**708** without performing roaming.
[0116] In step S**718**, the control unit **101** of the digital camera **100** transmits a connection request to the connection trial target AP also serving as a roaming target in order to perform connection processing in cooperation with the AP. The processing in step S**718** corresponds to S**611** in FIG. **6**.
[0117] In step S**719**, the control unit **101** of the digital camera **100** receives a connection OK notification from the connection trial target AP. The processing in step S**719** corresponds to S**612** in FIG. **6**.
[0118] In step S**720**, the control unit **101** of the digital camera **100** determines that the connection trial target AP is a desired AP, and establishes a wireless LAN connection with the AP. After the establishment, the control unit **101** transmits a connection completion notification to the AP, and receives a connection completion notification from the AP. The processing in step S**720** corresponds to S**613** in FIG. **6**.
[0119] According to the second embodiment, the digital camera **100** obtains the frequency band of a connected AP and that of a roaming target AP. When the digital camera **100** determines that the frequency band of the roaming target AP is smaller than that of the connected AP, it changes, to a small value, the RSSI threshold that is an RSSI condition serving as a roaming condition, so as to make transfer difficult. Also, when the digital camera **100** determines that the frequency band of the roaming target AP is smaller than that of the connected AP, it changes, to a large value, the condition of the communication deterioration determination time serving as a roaming condition, so as to make transfer difficult. When the digital camera **100** determines that the roaming condition is satisfied, it executes roaming. Hence, according to the embodiment, a decrease in throughput after roaming can be reduced, and roaming can be easily performed to a frequency band of high throughput.
[0120] Preferred embodiments of the present invention have been described above. However, the present invention is not limited to these embodiments, and various changes and modifications can be made without departing from the spirit and scope of the invention.
[0121] The above-described embodiments may be combined, or some processes may be omitted. For example, in the first embodiment, when the state in which the SNR of a connected AP becomes lower than an SNR threshold continues for the communication deterioration determination time, the control unit **101** may change the SNR threshold. In the second embodiment, when the RSSI of a connected AP becomes lower than an RSSI threshold, the control unit **101** may change the RSSI

threshold even if the communication deterioration determination time has not elapsed. The control unit **101** may be so constituted as to determine the roaming condition based on either the SNR or the RSSI, and the user may be able to select either the SNR threshold or the RSSI threshold.

[0122] The above-described embodiments have explained an example in which the frequency band of a connected AP and that of a roaming target AP are compared and the SNR threshold or the RSSI threshold is changed regardless of which of the frequency bands is larger. However, the present invention is not limited to this. For example, only when the frequency band of a roaming target AP is larger than that of a connected AP, the threshold may be changed. Alternatively, only when the frequency band of a roaming target AP is smaller than that of a connected AP, the threshold may be changed.

[0123] For example, in the above-described first embodiment, when the SNR becomes lower than the SNR threshold, processing from S**408** is executed. However, the condition that processing from S**408** is executed is not limited to this. For example, instead of or in addition to the above condition, when the signal strength of a connected AP becomes lower than a strength threshold (for example, 15), processing from S**408** may be executed.

[0124] For example, in the above-described second embodiment, when the RSSI becomes lower than the RSSI threshold, processing from S**608** is executed. However, the condition that processing from S**608** is executed is not limited to this. For example, instead of or in addition to the above condition, when a state in which the signal strength of a connected AP becomes lower than a strength threshold (for example, 15) continues for a communication deterioration determination time (for example, 30 sec), processing from S**608** may be executed.

Other Embodiments

[0125] Embodiment(s) of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.

[0126] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

[0127] This application claims the benefit of Japanese Patent Application No. 2024-021449, filed Feb. 15, 2024 which is hereby incorporated by reference herein in its entirety.

Claims

1. A communication apparatus comprising: an obtaining unit configured to obtain information of a plurality of access points of different frequency bands; a change unit configured to compare a frequency band during connection and a frequency band of a roaming target, and change a roaming condition for executing roaming; and an execution unit configured to execute roaming in a case where a signal of the frequency band during connection satisfies the roaming condition.

2. The apparatus according to claim 1, wherein the change unit changes a signal-to-noise ratio (SNR) condition as the roaming condition.

3. The apparatus according to claim 1, wherein the change unit changes a Received Signal Strength Indicator (RSSI) condition as the roaming condition.

4. The apparatus according to claim 1, wherein the change unit changes, as the roaming condition, a determination time for determining a time during which a communication time worsens.

5. The apparatus according to claim 2, wherein in a case where the frequency band of the roaming target is larger than the frequency band during connection, the change unit relaxes the SNR condition.

6. The apparatus according to claim 2, wherein in a case where the frequency band of the roaming target is smaller than the frequency band during connection, the change unit tightens the SNR condition.

7. The apparatus according to claim 3, wherein in a case where the frequency band of the roaming target is larger than the frequency band during connection, the change unit relaxes the RSSI condition.

8. The apparatus according to claim 3, wherein in a case where the frequency band of the roaming target is smaller than the frequency band during connection, the change unit tightens the RSSI condition.

9. The apparatus according to claim 4, wherein in a case where the frequency band of the roaming target is larger than the frequency band during connection, the change unit shortens the determination time.

10. The apparatus according to claim 4, wherein in a case where the frequency band of the roaming target is smaller than the frequency band during connection, the change unit prolongs the determination time.

11. A communication method comprising: obtaining information of a plurality of access points of different frequency bands; comparing a frequency band during connection and a frequency band of a roaming target to change a roaming condition for executing roaming; and executing roaming in a case where a signal of the frequency band during connection satisfies the roaming condition.

12. A non-transitory computer-readable storage medium storing a computer program that, when read and executed by a computer, causes the computer to function as an obtaining unit configured to obtain information of a plurality of access points of different frequency bands; a change unit configured to compare a frequency band during connection and a frequency band of a roaming target, and change a roaming condition for executing roaming; and an execution unit configured to execute roaming in a case where a signal of the frequency band during connection satisfies the roaming condition.