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(54) BROADCAST RECEIVER

(57) A broadcast receiver includes a storing means for storing information on a reception quality of a digital broadcasting signal detected at each of a plurality of points and location information of each of the plurality of points in an associated manner, a current position obtaining means for obtaining a current position, an estimating means for estimating, using the current position and the information stored in the storing means, whether reception quality of the digital broadcasting signal is expected to drop to or below the predetermined threshold, and a setting means for setting a reception operation for the analog broadcasting signal to an operation that requires reception of an analog broadcasting signal of a frequency different from a frequency of the analog broadcasting signal of simulcast according to a result of estimation by the estimating means.

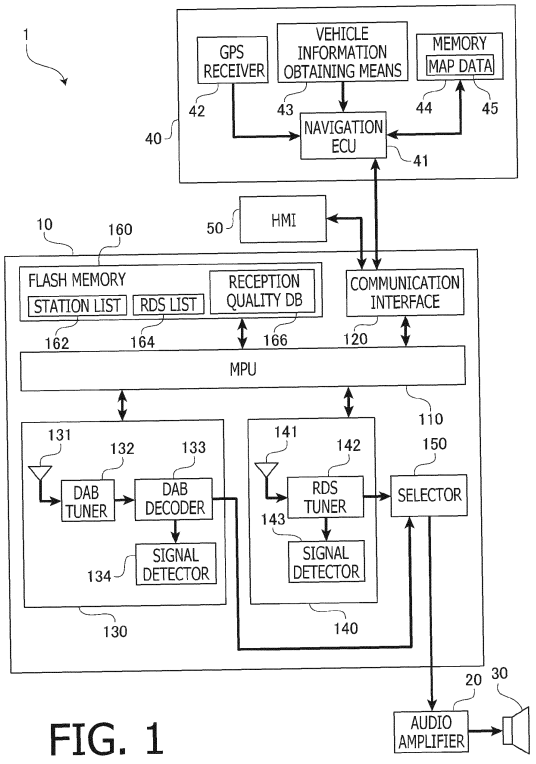

FIG. 1

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Description

Technical Field

[0001] The present invention relates to a broadcast receiver.

Related Art

[0002] There has been known a broadcast receiver configured to receive both ensemble signals of DAB (Digital Audio Broadcasting) and FM (Frequency Modulation) broadcasting signals of RDS (Radio Data System) (hereinafter referred to as "RDS signals") is known. An example of such a broadcast receiver is disclosed in Japanese Patent Provisional Publication No. 2014-116708.

[0003] In this type of broadcast receiver, for example, if the reception quality of the ensemble signal deteriorates, an automatic following to the simulcast providing the same service is performed based on an SID (Service Identifier) of the broadcasting service using the ensemble signal (hereinafter referred to as the "DAB service") and a PI (Program Identifier) of the broadcasting station that broadcasts simulcast using the RDS signal (hereinafter referred to as the "RDS simulcast"). In other words, when the reception quality of the ensemble signal deteriorates, the broadcast to be played back is automatically switched from the DAB service to the RDS simulcast. For the convenience of explanation, the operation of automatically switching from the DAB service to the RDS simulcast is hereinafter referred to as a "DAB-RDS link."

[0004] The broadcast receiver disclosed in the above-described publication is installed in a vehicle. Therefore, the reception quality of the ensemble signal fluctuates as the vehicle moves. Although the reception quality of the ensemble signal is detected in real-time, it is unclear when this reception quality will degrade to a level where the DAB service cannot be replayed. In order to quickly switch to the RDS simulcast when the reception quality of the ensemble signal deteriorates, it is necessary to continuously receive the RDS simulcast and prepare for the situation where the reception quality of the ensemble signal deteriorates to a level where DAB service cannot be played back.

Summary

[0005] Due to the DAB-RDS link, when the RDS simulcast is continuously received, the receiving frequency of the RDS tuner is fixed to the frequency that broadcasts the RDS simulcast. Therefore, the RDS tuner cannot perform operations that require the reception of RDS signals on a different frequency from the RDS simulcast, for example, operations to update the list of broadcasters that broadcast other than the RDS simulcast.

[0006] The present invention was made in consideration of the above circumstances, and provides a broadcast receiver capable of promptly executing the DAB-RDS link when the reception quality of the ensemble signal deteriorates, while permitting an operation that requires reception of the RDS signal on a different frequency from that of the RDS simulcast.

[0007] According to aspects of the present disclosures, a broadcast receiver implemented on a mobile device, the broadcast receiver being configured to receive a digital broadcasting signal and an analog broadcasting signal of which broadcast format differs from broadcast format of the digital broadcasting signal, the broadcast receiver being configured such that, when a reception quality of the digital broadcasting signal drops to or below a predetermined threshold, a broadcast to be played back being automatically switched from the digital broadcasting signal to the analog broadcasting signal of simulcast. The broadcast receiver includes a storing means for storing information on the reception quality of the digital broadcasting signal detected at each of a plurality of points and location information of each of the plurality of points in an associated manner, a current position obtaining means for obtaining a current position of the broadcast receiver, an estimating means for estimating, using the current position obtained by the current position obtaining means and the information stored in the storing means, whether reception quality of the digital broadcasting signal is expected to drop to or below the predetermined threshold, and a setting means for setting a reception operation for the analog broadcasting signal to an operation that requires reception of an analog broadcasting signal of a frequency different from a frequency of the analog broadcasting signal of simulcast according to a result of estimation by the estimating means.

Effect of the Invention

[0008] According to an embodiment of the present invention, the DAB-RDS link can be performed promptly when the reception quality of the ensemble signal deteriorates, while allowing broadcast receivers to operate, requiring the reception of the RDS signals on a different frequency other than the RDS simulcast.

Brief Description of the Drawings

[0009]

[Fig. 1] Fig. 1 is a block diagram showing a configuration of a broadcast receiving system according to an embodiment of the invention.

[Fig. 2] Fig. 2 is a flowchart illustrating a collecting process performed by an MPU (Micro Processing Means) according to the embodiment of the present invention.

[Fig. 3] Fig. 3 is a flowchart illustrating an operation setting process to set an operation of an RDS tuner performed by the MPU according to an embodiment of the present invention.

[Fig. 4] Fig. 4 is a diagram to assist in explaining the

operation setting process shown in Fig. 3.

[Fig. 5] Fig. 5 is a flowchart illustrating an operation setting process to set an operation of an RDS tuner performed by the MPU according to another embodiment of the present invention.

Detailed Description of the Embodiments

[0010] Embodiments of the present invention will be described below with reference to the drawings. In the following description, as an embodiment of the invention, there is described a broadcast receiving system that is implemented in a mobile device, configured to receive the DAB ensemble signals, which are digital broadcasting signals, and the RDS signals, which are analog broadcasting signals, and is equipped with a broadcast receiver that automatically switches the broadcast to be played from digital broadcasting signals to analog broadcasting signals for simulcasting when the reception quality of digital broadcasting signals drops below a predetermined threshold.

[0011] Fig. 1 shows a block diagram of a broadcast receiving system 1 according to an embodiment of the present invention. As shown in Fig. 1, the broadcast receiving system 1 has a broadcast receiver 10, an audio amplifier 20, a speaker 30, a navigation device 40, and an HMI (Human Machine Interface) 50.

[0012] The broadcast receiver 10 is a device configured to receive the DAB ensemble signals and the simulcast RDS signals, of which broadcast format differs from broadcast format of the ensemble signals. The broadcast receiver 10 is installed, for example, in a vehicle. The broadcast receiver 10 is not necessarily limited to in-vehicle devices but may be installed, for example, in smartphones, feature phones, PHSs (Personal Handy phone System), tablet terminals, notebook PCs, PDAs (Personal Digital Assistant), PNDs (Portable Navigation Device), portable game machines, or other portable terminals.

[0013] In this embodiment, the broadcast receiver 10 and the navigation device 40 are separate and independent devices, but in another embodiment, the broadcast receiver 10 may be a device that includes the navigation device 40.

[0014] As shown in Fig. 1, the broadcast receiver 10 is equipped with an MPU 110, a communication interface 120, a DAB signal processing circuit 130, an RDS signal processing circuit 140, a selector 150, and a flash memory 160. An audio amplifier 20 and a speaker 30 are connected to a rear stage of the broadcast receiver 10 (specifically, to the selector 150).

[0015] In Fig. 1, the main components necessary to describe this embodiment are illustrated. Some components, such as a housing, which are an essential component of the broadcast receiver 10 but not necessary to explain the present invention, are omitted from the drawings as appropriate.

[0016] For example, when an engine of a vehicle is turned on, power is supplied from a battery, which is not shown in the drawings, to each circuit of the broadcast receiver 10 through a power supply line. After the power is supplied, the MPU 110 retrieves the control program stored in an internal memory, loads the control program into a work area, and executes the loaded control program to control the entire broadcast receiver 10.

[0017] An HMI 50 is an interface via which information is exchanged between a user, and the broadcast receiver 10 and the navigation device 40. Concretely, the HMI 50 is a touch panel display and mechanical keys arranged around the touch panel display, a remote controller, and the like.

[0018] The MPU 110 is communicatively connected to the HMI 50 via the communication interface 120. The MPU 110 outputs receive control signals to the DAB signal processing circuit 130 and the RDS signal processing circuit 140 according to a station selection operation to the HMI 50.

[0019] The DAB signal processing circuit 130 is a circuit for receiving and processing the ensemble signals and is equipped with an antenna 131, a DAB tuner 132, a DAB decoder 133 and a signal detector 134.

[0020] The DAB tuner 132 converts the ensemble signal received by the antenna 131 from an RF (Radio Frequency) signal to a baseband signal according to the reception control signal input from the MPU 110, and outputs the converted signal to the DAB decoder 133.

[0021] The DAB decoder 133 applies an OFDM (Orthogonal Frequency Division Multiplexing) demodulation to the baseband signal input from the DAB tuner 132.

[0022] The ensemble signal is roughly composed of a synchronization channel used for frame synchronization during demodulation, a Fast Information Channel (FIC) that contains service configuration information and the like, and a Main Service Channel (MSC) that contains voice and data services.

[0023] The FIC includes a Fast Information Block (FIB), which contains identifiers such as an SID, an EID (Ensemble Identifier), an SCIdS (Service Component Identifier within the Service) and the like, and label data associated with the identifiers (e.g., a service label indicating a name of a broadcasting service (i.e., a name of a broadcasting program)). The FIB includes an FIG (Fast Information Group) and a CRC (Cyclic Redundancy Check). The FIGs are classified into eight types, from Type 0 to Type 7, depending on usages.

[0024] The FIG contains service linking information. The service linking information contains information that indicates which SID in the DAB is linked to which PI in the RDS. The service linking information allows the MPU 110 to identify the RDS station that broadcasts the same service as the currently received DAB station, not only for broadcasts of which SID and PI match, but also for broadcasts of which SID and PI do not match.

[0025] The DAB decoder 133 transmits the FIC obtained from the OFDM demodulation to the MPU 110. The MPU 110 selects the DAB service to be played back from among multiple DAB services multiplexed in the en-

semble signal based on the information in the FIC.

[0026] The DAB decoder 133 decodes audio data and display data which are included in the MSC, and are the audio data and the display data of a sub-channel corresponding to the DAB service selected by the MPU 110. The DAB decoder 133 then outputs the decoded audio data (hereinafter referred to as "DAB audio signal") to the selector 150, and the decoded display data to the HMI 50.

[0027] The signal detector 134 detects information on the reception quality of the ensemble signal (hereinafter referred to as "DAB reception quality information"). The DAB reception quality information is information indicated, for example, as a reception level or a bit error rate of the ensemble signal.

[0028] The RDS signal processing circuit 140 is a circuit configured to perform a receiving process of the RDS signals and is equipped with an antenna 141, an RDS tuner 142 and a signal detector 143.

[0029] The antenna 14 is configured to receive the RDS signal. The RDS tuner 142 is configured to modulate the RDS signal received by the antenna 141 according to the reception control signal input from the MPU 110. The RDS simulcast selected by the FM modulation is an RDS simulcast broadcasted by a broadcaster with the same PI as the SID of the DAB service or an RDS simulcast broadcasted by a broadcaster with the PI associated with the SID of the DAB service by service linking information.

[0030] By the FM modulation, audio signals (hereinafter referred to as "RDS audio signals") and character information data are obtained. The RDS audio signal and character information data obtained by FM modulation are output to the audio amplifier 20 and HMI 50, respectively.

[0031] The signal detector 143 is configured to detect information on the reception quality of the RDS simulcast (hereinafter referred to as "RDS reception quality information"). The RDS reception quality information is information indicated by the reception level of the RDS simulcast.

[0032] The MPU 110 outputs a selector signal to the selector 150. In accordance with the selector signal input from the MPU 110, the selector 150 outputs the RDS audio signal or the DAB audio signal. The selector 150 outputs the RDS audio signal when the reception quality of the ensemble signal is in a degraded state (i.e., when the reception quality of the ensemble signal is equal to or below a predetermined threshold, and exemplarily, when a bit error rate of the ensemble signal is equal to or above a first threshold). Further , the selector 150 outputs the DAB audio signal when the reception quality of the ensemble signal is in a good or improved state (i.e., when the reception quality of the ensemble signal is above the predetermined threshold, and exemplarily, when the bit error rate of the ensemble signal is below the first threshold). The audio signal output from the selector 150 is amplified by the audio amplifier 20 and played by the speaker 30.

[0033] The MPU 110 checks the reception quality of the ensemble signals based on the DAB reception quality information detected by the signal detector 134, and also checks the reception quality of the RDS signals based on the RDS reception quality information detected by the signal detector 143. The reception qualities above are degraded when the vehicle in which the broadcast receiver 10 is installed is out of a receivable area or is affected by buildings, tunnels, or other shielding. When the reception quality of the ensemble signal is degraded, the MPU 110 outputs the selector signal to the selector 150 to switch the broadcast to be played to the RDS simulcast that broadcasts the same content as the DAB service. In other words, the MPU 110 executes the DAB-RDS link.

[0034] A station list of the DAB will be described. The station list is list data that holds information such as a frequency channel, an ensemble label, a service label, the SID, the SCIdS, a type (Primary, Secondary), the hard link service information, the FI, and OE (Other Ensembles) service in an associated manner.

[0035] For example, the MPU 110 controls the DAB signal processing circuit 130 to seek all frequency channels that broadcast the DAB ensemble signal. In general, the MPU 110 outputs a receive control signal to the DAB signal processing circuit 130 and instructs to select one frequency channel. The DAB signal processing circuit 130 performs the reception process in accordance with the reception control signal input from the MPU 110. When the DAB signal processing circuit 130 detects the ensemble signal and the demodulation process is successful, the service configuration information necessary for generating the station list 162 is obtained and output to the MPU 110. When the MPU 110 obtains the service configuration information from the DAB signal processing circuit 130, the MPU 100 instructs the DAB signal processing circuit 130 to select the next frequency channel and tries to obtain the service configuration information for the next frequency channel as well. When the MPU 110 cannot acquire the service configuration information from the DAB signal processing circuit 130 within a certain period of time, the MPU 110 instructs the DAB signal processing circuit 130 to select the next frequency channel and tries to acquire the service configuration information. The MPU 110 performs this seek process for all frequency channels that broadcast the ensemble signal.

[0036] When the MPU 110 obtains the results of obtaining or failing to obtain the service configuration information for all frequency channels that broadcast ensemble signals, the MPU 110 generates a station list 162 based on the obtained service configuration information and stores the generated station list 162 in the flash memory 160.

[0037] The service labels held by the station list 162 are displayed, for example, on the touch panel display of the HMI 50. The user can select a desired service label (in other words, a DAB service) from the station list 162

displayed on the touch panel display of the HMI 50 by a touching operation. When the DAB service on the station list 162 is selected, the MPU 110 receives the ensemble signal based on the frequency, EID, SID and the like of the ensemble signal stored in association with the selected DAB service, and sends the speaker 30 the DAB audio signal of the selected station included in the received ensemble signal to play the DAB audio signal. Further, the MPU 110 displays the data for display of this DAB service on the touch panel display.

[0038] The service labels registered by preset operations (in other words, the DAB services) can also be displayed on the touch panel display of the HMI 50. By making a selection operation for the preset registered DAB services, the user can make the DAB audio signal of the selected DAB service be played by the speaker 30, and also make the display data for the DAB services be displayed on the touch panel display.

[0039] The flash memory 160 also stores a list of broadcast stations (hereinafter referred to as an "RDS list 164") that broadcast the RDS that can be received. The RDS list 164 is list data that holds information such as the frequency channel, the PI, a PS (Program Service), a PTY (Program Type) and the like in an associated manner. The MPU 110 performs a seek process for all the frequency channels that broadcast the RDS signals to obtain each information in the same way as in a case where the station list 162 is generated. The generated RDS list 164 is saved (overwritten) in the flash memory 160. The process of seeking the RDS signals to generate and save the RDS list is hereinafter referred to as an "RDS list update process."

[0040] As shown in Fig. 1, the navigation device 40 is equipped with a navigation ECU (Electronic Control Means) 41, a GPS receiver 42, a vehicle information obtaining means 43, and a memory 44.

[0041] In the memory 44, the control program and various data used by the navigation ECU 41 for processing (for example, map data 45, or reference values referred to in the program) are stored. For example, when the engine of the vehicle is started, a power supply is started from the battery, which is not shown in the figure, to each circuit of the navigation device 40 through the power supply lines. After the power supply is started, the navigation ECU 41 retrieves the control program stored in the memory 44, loads the retrieved program into the work area, and controls the entire navigation device 40 by executing the loaded control program.

[0042] The GPS receiver 42 is a module configured to measure the current position of the GPS receiver 42 based on the GPS signals received from a plurality of GPS satellites. The GPS receiver 42 is configured to measure the current position at predetermined time intervals (e.g., every one second) and output the measurement results to the navigation ECU 41.

[0043] The broadcast receiver 10 and the GPS receiver 42 are installed in close proximity to each other in the same vehicle and move integrally. Therefore, although the current position measured by the GPS receiver 42 is strictly the current position of the GPS receiver 42, the measured position can be regarded as the current position of the broadcast receiver 10 or the current position of the vehicle.

[0044] The MPU 110 is configured to communicate with the navigation device 40 via the communication interface 120. Each time the GPS receiver 42 measures the current position, the MPU 110 communicates with the navigation device 40, and the navigation device 40 informs the MPU 110 of the current position measured by the GPS receiver 42.

[0045] That is, the MPU 110 is connected to the GPS receiver 42 and operates as a current position obtaining means to obtain the current position of the broadcast receiver 10 from the output of the GPS receiver 42.

[0046] The navigation ECU 41 renders the map data 45 read from the memory 44 and displays the rendered data on the touch panel display of the HMI 50, obtains the current position measured by the GPS receiver 42, and superimposes a mark indicating the position of the vehicle on a road shown in the map displayed on the touch panel display (i.e., performs map matching).

[0047] It is noted that the map data 45 is data described in accordance with a network structure which is formed using nodes and links.

[0048] The vehicle information obtaining means 43 is a DR (Dead Reckoning) sensor which is, for example, a gyro sensor configured to measure an angular velocity related to the orientation of the vehicle in a horizontal plane, or a vehicle speed sensor configured to detect a rotational speed of the right and left drive wheels of the vehicle. The navigation ECU 41 may be configured to estimate the current position from the information obtained from the vehicle information obtaining means 43. The navigation ECU 41 may be configured to determine the final current position after comparing the current position obtained from the GPS receiver 42 and the current position estimated based on the information obtained from the vehicle information obtaining means 43.

[0049] When performing a route guidance, the navigation ECU 41 highlights the route in the map displayed on the touch panel display of the HMI 50. The navigation ECU 41 is configured to periodically obtain the current position and display a map that matches the obtained current position on the touch panel display. Further, the navigation ECU 41 is configured to play an audio signal for route guidance on the speaker 30 in a timely manner. When the current position deviates from the route, the route is re-searched and re-set using the Dijkstra method. The navigation ECU 41 can also download the latest map data 45 by periodically connecting to a predetermined map server on the Internet.

[0050] The broadcast receiver 10 is installed in a vehicle, which is a moving object. Therefore, the reception quality of the ensemble signal received by the broadcast receiver 10 fluctuates as the vehicle moves. Although the reception quality of the ensemble signal is detected

in real-time by the signal detector 134, it is unknown when the reception quality will deteriorate to a level where the DAB service cannot be reproduced. In order to quickly switch to the RDS simulcast when the reception quality of the ensemble signal deteriorates, it is necessary to fix the reception frequency of the RDS tuner 142 to the frequency at which the RDS simulcast is broadcasted and to continuously receive the RDS simulcast. The operations of fixing the receiving frequency of the RDS tuner 142 to the frequency that broadcasts the RDS simulcast and continuously receiving the RDS simulcast are hereinafter referred to as a "DAB-RDS link standby operation."

[0051] In a broadcast receiver, which is equipped with only one RDS tuner 142, such as the broadcast receiver 10, it is not possible to perform operations that require the reception of RDS signals on a frequency different from the frequency of the RDS simulcast (for example, an RDS list updating process) during the DAB-RDS link standby operation. In the following description, the operation that requires the reception of the RDS signal of a different frequency from the RDS simulcast is hereinafter referred to as "non-fixed frequency operation."

[0052] In order to execute the non-fixed frequency operation, it is necessary to temporarily suspend the DAB-RDS link standby operation. However, if the DAB-RDS link standby operation is temporarily suspended, the DAB-RDS link may not be executed promptly, depending on the timing of the degradation of the ensemble signal reception quality.

[0053] Therefore, in this embodiment, in order to allow operations that require reception of the RDS signals on a frequency different from that of the RDS simulcast, while allowing the DAB-RDS link to be executed promptly when the reception quality of the ensemble signal deteriorates, the MPU 110 performs the processes indicated in the flowcharts shown in Figs. 2 and 3.

[0054] Fig. 2 is a flowchart illustrating a collecting process performed by the MPU 110 according to the present embodiment. The collecting process shown in Fig. 2 starts, for example, when the power of the broadcast receiver 10 is turned on, and is repeatedly performed until the power of the broadcast receiver 10 is turned off.

[0055] The MPU 110 is notified of the current position of the broadcast receiver 10 at predetermined time intervals (i.e., intervals of measurement by the GPS receiver 42) from the navigation device 40. That is, the MPU 110 obtains the current position of the broadcast receiver 10 from the navigation device 40 at predetermined time intervals (S 101).

[0056] When the MPU 110 obtains the current position of the broadcast receiver 10 in S101, the MPU 110 obtains the DAB reception quality information detected by the signal detector 134 at that time (S 102).

[0057] In other words, the MPU 110 operates as a reception quality obtaining means configured to obtain the reception quality of the digital broadcasting signals when the current position is obtained by the current position obtaining means.

[0058] The MPU 110 associates the current position of the broadcast receiver 10 obtained in S101 with the DAB reception quality information obtained in S102 and stores the same in a reception quality DB (Data Base) 166 (S103).

[0059] In the present embodiment, links constituting the map data 45 stored in the memory 44 correspond to the above points, respectively. Therefore, in the present embodiment, the link of the map data 45 and the DAB reception quality information obtained during travelling along the road corresponding to the link are stored in the reception quality DB 166 in an associated manner.

[0060] The DAB reception quality information stored in association with the link is, for example, an average value of the DAB reception quality information obtained while the vehicle is travelling along the road corresponding to the link. Instead of this average value, the median or the most frequent value of the DAB reception quality information obtained during the travelling along the road corresponding to the link or one piece of DAB reception quality information determined according to a predetermined rule may be stored in association with the link.

[0061] When the DAB reception quality information is newly obtained for a link for which DAB reception quality information has already been associated and stored, the MPU 110 overwrites the newly obtained DAB reception quality information in association with the link.

[0062] In this way, the MPU 110 operates as a storing means that stores the information on the reception quality of digital broadcasting signals detected at the multiple points and the location information of respective points in an associated manner.

[0063] Fig. 3 is a flowchart illustrating an operation setting process for setting the operation of the RDS tuner 142, which is performed by the MPU 110 in the present embodiment. The operation setting process starts, for example, when the power of the broadcast receiver 10 is turned on, and is repeatedly performed until the power of the broadcast receiver 10 is turned off. The operation setting process is performed in parallel with the collecting process shown in Fig. 2.

[0064] Fig. 4 is a diagram that assists in the explanation of the operation setting process shown in Fig. 3. In Fig. 4, some nodes of the map data 45 stored in the memory 44 and links L1 to L10 connecting these nodes are shown. In Fig. 4, reference symbols PI, P2 and P3 indicate vehicles (in other words, the broadcast receivers 10) that are travelling along the links L1, L3 and L8, respectively.

[0065] In Fig. 4, links L1 to L9, which are associated with DAB reception quality information having the receive qualities of the ensemble signals exceeding a predetermined threshold in the receive quality DB 166, are indicated by solid lines. Further, a link L10, which is associated with DAB reception quality information, which has the receive quality of the ensemble signal equal to or lower than the predetermined threshold in the receive quality DB 166, is indicated by broken lines.

[0066] For the sake of convenience, a link associated with the DAB reception quality information where the reception quality of the ensemble signal exceeds the predetermined threshold will be referred to as an "OK reception quality link," and links associated with the DAB reception quality information where the reception quality of the ensemble signal is equal to or below the predetermined threshold will be referred to as an "NG reception quality link."

[0067] An arrow A indicates a travelling direction of the vehicle travelling on the link L1. An arrow B indicates a travelling direction of a vehicle travelling on the link L3. An arrow C indicates a travelling direction of a vehicle travelling on the link L8. In the example of Fig. 4, a case where the vehicle is travelling on the link L1 (see symbol PI and arrow A) will be referred to as "travelling example A," a case where the vehicle is travelling on the link L3 (see symbol P2 and arrow B) will be referred to as "travelling example B," and a case where the vehicle is travelling on the link L8 (see symbol P3 and arrow C) will be referred to as "travelling example C."

[0068] The MPU 110 estimates a travelling direction and a travelling speed of the broadcast receiver 10 on the map indicated by the map data 45 (S201 of Fig. 3). The travelling direction and the travelling speed are estimated, for example, based on a predetermined number (e.g., five) of current positions that the MPU 110 has most recently obtained from the navigation device 40. Specifically, the travelling direction of the broadcast receiver 10 is estimated based on the chronological order of the predetermined number of current positions obtained most recently. Further, the travelling speed of the broadcast receiver 10 is estimated based on the distance interval among the predetermined number of current positions obtained at predetermined time intervals.

[0069] Instead of the predetermined number of most recently obtained current positions, the travelling direction and the speed of the broadcast receiver 10 may be estimated based on the output of the gyro sensor and the vehicle speed sensor, or based on the speed calculated based on the output of the GPS receiver 42 and the outputs of such sensors.

[0070] The MPU 110 detects the link that the broadcast receiver 10 is expected to reach within a predetermined time (e.g., 30 seconds) from its current position based on the travelling direction and the speed of travel estimated in step S201 (step S202).

[0071] For example, in the travelling example A, the links L1 to L6 are detected as links that the broadcast receiver 10 is expected to reach within the predetermined time from the current position. In the travelling example B, the links L3 to L10 are detected as links that the broadcast receiver 10 is expected to reach within the predetermined time from the current position. In the travelling example C, the links L2 to L8 are detected as links that the broadcast receiver 10 is expected to reach within the predetermined time from the current position.

[0072] The MPU 110 determines whether the DAB reception quality information is stored in an associated manner for all the links detected in step S202 in the receive quality DB 166 (step S203).

[0073] When the DAB reception quality information is stored in the associated manner for all the links detected in step S202 (step S203: YES), the MPU 110 determines whether the links detected in step S202 (i.e., links that the broadcast receiver 10 is expected to reach within the predetermined time from the current position) includes the NG reception quality links or not (step S204).

[0074] When the NG reception quality link is included among the links that the broadcast receiver 10 is expected to reach within a predetermined time from the current position (S204: YES), it is highly likely that the reception quality of the ensemble signal will drop to or below the predetermined threshold within the predetermined time period.

[0075] Therefore, when the NG reception quality link is included (S204: YES), the MPU 110 estimates that the reception quality of the ensemble signal will drop to or below the predetermined threshold within the predetermined time. Then, in preparation for this drop in the reception quality, the MPU 110 sets the operation of the RDS tuner 142 to the DAB-RDS link standby operation (S205).

[0076] On the other hand, when no NG links of reception quality are included among the links that the broadcast receiver 10 is expected to reach within a predetermined time from the current position (in other words, they are all OK reception quality links) (S204: NO), it is unlikely that the reception quality of the ensemble signal will drop to or below the predetermined threshold.

[0077] Therefore, when no NG reception quality link is included (S204: NO), the MPU 110 estimates that the reception quality of the ensemble signal will not drop to or below the predetermined threshold within the predetermined time, determines that the DAB-RDS link standby operation is unnecessary at this time, and sets the operation of the RDS tuner 142 operation to the non-fixed frequency operation such as the RDS list update process (S206).

[0078] In the travelling example B in Fig. 4, the link L10, which is the NG reception quality link, is included among the links that the broadcast receiver 10 is expected to reach within the predetermined time from its current position. When the broadcast receiver 10 moves to the link L10, the reception quality of the ensemble signal is likely to drop to or below the predetermined threshold within the predetermined time. Therefore, in the travelling example B, the operation of the RDS tuner 142 is set to the DAB-RDS link standby operation in preparation for the degradation of the reception quality of the ensemble signal.

[0079] On the other hand, in the travelling examples A and C in Fig. 4, no NG reception quality link is included among the links that the broadcast receiver 10 is expected to reach within the predetermined time from its current position. Therefore, no matter which path the broadcast

receiver 10 takes, the reception quality of the ensemble signal is unlikely to drop to or below the predetermined threshold within the predetermined time. Therefore, in the travelling examples A and C, the operation of the RDS tuner 142 is set to the non-fixed frequency operation such as the RDS list update process, assuming that the DAB-RDS link standby operation is unnecessary at this time.

[0080] Thus, the MPU 110 operates as an estimating means that estimates whether or not the reception quality of the digital broadcasting signal will drop to or below the predetermined threshold using the current position obtained by the current position obtaining means and the information stored in the storing means (information in the reception quality DB 166). Incidentally, the MPU 110, which serves as the estimating means, estimates the travelling direction and the travelling speed of the broadcast receiver 10 on the map indicated by the map data 45. Then, the MPU 110 uses the estimated travelling direction and the travelling speed as well as the current position obtained by the current position obtaining means to determine whether the broadcast receiver 10 is expected to reach the point associated with the information indicating that the reception quality of the digital broadcasting signal is equal to or below the predetermined threshold (in this case, the NG reception quality link) within the predetermined time. When it is determined that the broadcast receiver 10 is expected to reach the point within the predetermined time, the MPU 110 estimates that the reception quality of the digital broadcasting signal will drop to or below the predetermined threshold.

[0081] Further, the MPU 110 operates as a setting means that sets the reception operation for the analog broadcasting signal to an operation that requires reception of an analog broadcasting signal of a frequency different from that of the simulcast analog broadcasting signal (in this case, non-fixed frequency operation) according to the estimation result by the estimating means. Incidentally, when the MPU 110, which serves as the setting means, estimates that the reception quality of the digital broadcasting signal will drop to or below a predetermined threshold, the MPU 110 sets the reception operation for the analog broadcasting signal to the operation to receive the analog broadcasting signal of simulcast (in this case, the DAB-RDS link standby operation). When the MPU 110 estimates that the reception quality of the digital broadcasting signal will not drop below the predetermined threshold, the MPU 110 sets the reception operation for the analog broadcasting signal to an operation that requires the reception of an analog broadcasting signal with a frequency different from that of the simulcast analog broadcasting signal (in this case, non-fixed frequency operation).

[0082] In the present embodiment, when the reception quality of the ensemble signal is expected to drop to or below the predetermined threshold, the operation of the RDS tuner 142 is set to the DAB-RDS link standby operation before the reception quality of the ensemble signal actually drops. Therefore, when the reception quality of the ensemble signal actually decreases, the DAB-RDS link can be executed promptly. In a situation where the reception quality of the ensemble signal is unlikely to drop to or below the predetermined threshold within the predetermined time, a malfunction that the DAB service cannot be played occurs hardly. Therefore, in the present embodiment, the operation of the RDS tuner 142 is set to the non-fixed frequency operation. In other words, according to the broadcast receiver 10 of the present embodiment, the DAB-RDS link can be executed promptly when the reception quality of the ensemble signal deteriorates while allowing the operation that requires reception of the RDS signal of a frequency different from the RDS simulcast.

[0083] When even one link with which no DAB reception quality information is associated is included in the links detected in S202 (S203: NO), there is a possibility that the link with which no DAB reception quality information is associated is the NG reception quality link. Therefore, in such a case, the MPU 110 sets the operation of the RDS tuner 142 to the DAB-RDS link standby operation (S205) in preparation for the possibility that the reception quality of the ensemble signal may be degraded.

[0084] The embodiments according to the present invention are not necessarily limited to those described above, but various modifications are possible within aspects of the technical concept of the present invention. For example, the examples described in the specification or combinations of explicitly described examples are also included in the embodiments of the present application.

[0085] In the above embodiment, the RDS list update process is illustrated as the non-fixed frequency operation. The present invention is not necessarily be limited to the RDS list update process described above. The non-fixed frequency operation may be, for example, an operation that allows the RDS tuner 142 to change its receiving frequency to the frequency specified by a TA (Traffic Announcement) flag when the TA flag is detected in the RDS signal.

[0086] When the reception quality of the ensemble signal is not expected to drop to or below the predetermined threshold within the predetermined time, the MPU 110 changes the reception frequency of the RDS tuner 142 to the frequency specified by the TA flag when the TA flag is detected. In contrast, when the reception quality of the ensemble signal is expected to drop to or below the predetermined threshold within the predetermined time, the MPU 110 does not change the operation of the RDS tuner 142 from the DAB-RDS link standby operation, even if the TA flag is detected.

[0087] In the above embodiment, the operation of the RDS tuner 142 is set to the DAB-RDS link standby operation when the NG reception quality link is included in the links that the broadcast receiver 10 is expected to reach within the predetermined time from the current position, but the invention is not necessarily limited to this

configuration. For example, when the NG reception quality link is included within the predetermined distance along the travelling direction from the current position, the operation of the RDS tuner 142 may be set to the DAB-RDS link standby operation. Fig. 5 is a flowchart illustrating such a configuration.

[0088] In Fig. 5, the MPU 110 estimates the travelling direction of the broadcast receiver 10 on the map indicated by the map data 45 (S301).

[0089] Next, in S302, the MPU 110 detects links within a predetermined distance (e.g., 1 km) along the travelling direction estimated in S301. For example, in the travelling example A shown in Fig. 4, the link that the broadcast receiver 10 travelling in the direction of arrow A passes when the broadcast receiver 10 moves along the link by the predetermined distance is detected.

[0090] In S303, the MPU 110 determines whether the DAB reception quality information is stored in association with all the links detected in the receive quality DB 166.

[0091] When the DAB reception quality information is associated and stored for all links detected in S302 (S303: YES), the MPU 110 determines whether the links detected in step S302 (i.e., links within the predetermined distance along the travelling direction) include the NG reception quality links (S304).

[0092] When the NG reception quality link is included among the links within the predetermined distance along the travelling direction from the current position (S304: YES), the reception quality of the ensemble signal is likely to drop to or below the predetermined threshold soon, depending on the path taken by the broadcast receiver 10.

[0093] Therefore, when the NG reception quality link is included (S304: YES), the MPU 110 estimates that the reception quality of the ensemble signal will drop to or below the predetermined threshold, and in preparation for this drop in the reception quality, the MPU 110 sets the operation of the RDS tuner 142 to the DAB-RDS link standby operation (S305).

[0094] On the other hand, when no NG links of reception quality are included among the links within the predetermined distance along the travelling direction from the current position (in other words, all of them are OK reception quality links) (S304: NO), the reception quality of the ensemble signal is unlikely to drop to or below the predetermined threshold.

[0095] Therefore, when no NG reception quality link is included (S304: NO), the MPU 110 estimates that the reception quality of the ensemble signal will not drop to or below a predetermined threshold, determines that the DAB-RDS link standby operation is unnecessary at this time, and then sets the operation of the RDS tuner 142 to the non-fixed frequency operation such as the RDS list update process (S306).

[0096] In this way, the MPU 110 operating as the estimating means estimates the travelling direction of the broadcast receiver 10 on the map indicated by the map data 45, and uses the estimated travelling direction and the current position obtained by the current position obtaining means to determine whether a point associated with information representing the reception quality of the digital broadcasting signal which is equal to or below the predetermined threshold (in this case, an NG reception quality link) exists within the predetermined distance along the travelling direction. When it is determined that the link exists within the predetermined distance, the reception quality of the digital broadcasting signal is estimated to drop to or below the predetermined threshold.

[0097] Also in this example, when there is a high possibility that the reception quality of the ensemble signal will drop to or below the predetermined threshold, the operation of the RDS tuner 142 is set to the DAB-RDS link standby operation before the reception quality of the ensemble signal actually drops. Therefore, when the reception quality of the ensemble signal actually decreases, the DAB-RDS link can be executed promptly. Further, in a situation where the reception quality of the ensemble signal is unlikely to drop to or below the predetermined threshold, the operation of the RDS tuner 142 is set to the non-fixed frequency operation. That is, also in this example, the DAB-RDS link can be executed promptly when the reception quality of the ensemble signal degrades, while allowing the operation that requires reception of the RDS signal on a frequency different from that of the RDS simulcast.

[0098] When even one link which is not associated with the DAB reception quality information is included in the links detected in S302 (S303: NO), the operation of the RDS tuner 142 is set to the DAB-RDS link standby operation as in the example shown in Fig. 3 (S305).

Claims

1. A broadcast receiver (10) implemented on a mobile device, the broadcast receiver (10) being configured to receive a digital broadcasting signal and an analog broadcasting signal of which broadcast format differs from broadcast format of the digital broadcasting signal, the broadcast receiver (10) being configured such that, when a reception quality of the digital broadcasting signal drops to or below a predetermined threshold, a broadcast to be played back being automatically switched from the digital broadcasting signal to the analog broadcasting signal of simulcast,
   the broadcast receiver (10) comprising:

   a storing means (160) for storing information on the reception quality of the digital broadcasting signal detected at each of a plurality of points and location information of each of the plurality of points in an associated manner;
   a current position obtaining means (42) for obtaining a current position of the broadcast receiver (10);

an estimating means (150) for estimating, using the current position obtained by the current position obtaining means and the information stored in the storing means, whether reception quality of the digital broadcasting signal is expected to drop to or below the predetermined threshold; and

a setting means (110) for setting a reception operation for the analog broadcasting signal to an operation that requires reception of an analog broadcasting signal of a frequency different from a frequency of the analog broadcasting signal of simulcast according to a result of estimation by the estimating means (150).

2. The broadcast receiver (10) according to claim 1, wherein the setting means is configured to:

set the reception operation for the analog broadcasting signal to an operation of receiving the analog broadcasting signal of simulcast when the estimating means estimates that the reception quality drops to or below the predetermined threshold; and

set the reception operation for the analog broadcasting signal to an operation requiring reception of an analog broadcasting signal of a frequency different from the frequency of the analog broadcasting signal of simulcast when the estimating means estimates that the reception quality does not drop to or below the predetermined threshold.

3. The broadcast receiver according to claim 2, wherein the operation requiring reception of the analog broadcasting signal the frequency different from the frequency of the analog broadcasting signal of simulcast is an operation of updating a list of broadcast stations that broadcast receivable analog broadcasting signals, respectively.

4. The broadcast receiver according to any one of claim 1 to claim 3,

further comprising a reception quality obtaining means (134) configured to obtain reception quality of the digital broadcasting signal when the current position is obtained by the current position obtaining means,

wherein, when the reception quality of the digital broadcasting signal is obtained by the reception quality obtaining means (134), the storing means (160) stores information of the obtained reception quality and the current position obtained by the current position obtaining means (42) in an associated manner.

5. The broadcast receiver according to claim 4,

wherein the storing means (160) is configured to store position information of each of the plurality of points on a map represented by a particular map data and information of the reception quality at each of the plurality of points in an associated manner,

wherein the estimating means (150) is configured to:

estimate a traveling direction and a traveling speed of the broadcast receiver (10) on the map indicated by the particular map data;

determine whether the broadcast receiver (10) reaches a point associated with the information representing the reception quality which is equal to or less than the predetermined threshold within a predetermined time by using the estimated traveling direction and traveling speed and the current position obtained by the current position obtaining means (42); and

estimate that the reception quality drops to or below the predetermined threshold when it is determined that the broadcast receiver (10) reaches the point within the predetermined time.

6. The broadcast receiver (10) according to claim 4,

wherein the storing means (160) is configured to store position information of each of the plurality of points on a map represented by a particular map data and information of the reception quality at each of the plurality of points in an associated manner,

wherein the estimating means (150) is configured to:

estimates a traveling direction of the broadcast receiver (150) on the map indicated by the particular map data;

determine whether a point associated with information representing the reception quality which is equal to or lower than the predetermined threshold exists within a predetermined distance along the traveling direction from the current position using the estimated traveling direction and the current position obtained by the current position obtaining means; and

estimate that the reception quality drops to or below the predetermined threshold when it is determined that the point exists within the predetermined distance.

7. The broadcast receiver according to claim 5 or claim 6,

wherein the particular map data is data described by a network structure formed using a node and a link, and
wherein the storing means (160) is configured to store the link of the particular map data and the information on the reception quality obtained by the reception quality obtaining means while the broadcast receiver (10) is traveling on a road corresponding to the link in an associated manner.

8. The broadcast receiver according to claim 7,

wherein the reception quality obtaining means (134) is configured to obtain the reception quality of the digital broadcasting signal at a predetermined time interval, and
wherein the storing means (160) is configured to store an average value of the reception qualities obtained while the broadcast receiver (10) is traveling on a road corresponding to the link in an associated manner.

9. The broadcast receiver according to any one of claim 1 to claim 8,
wherein the current position obtaining means (40) is connected to a GPS receiver (42) and configured to obtain the current position from the GPS receiver (42).

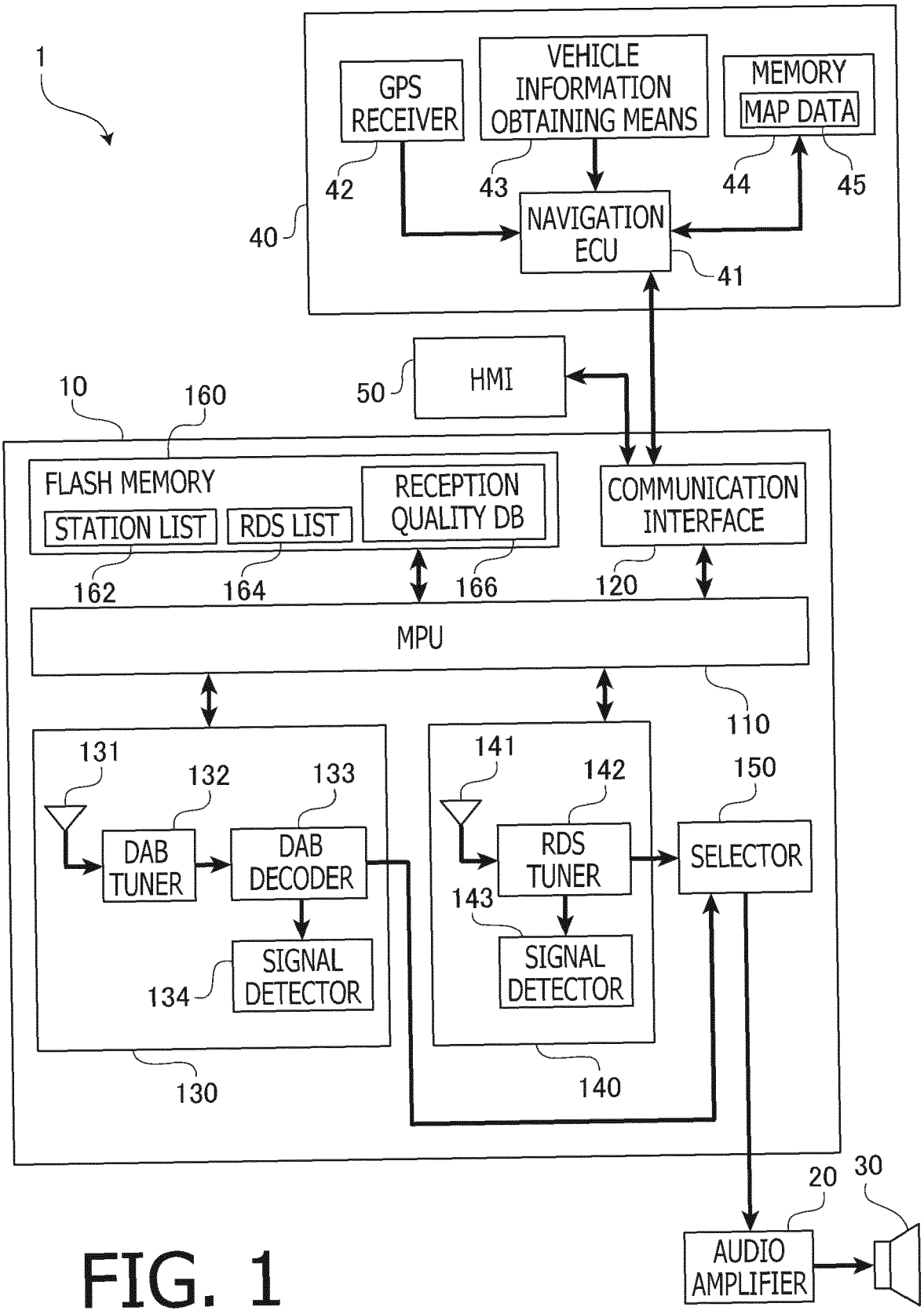
1
GPS RECEIVER
VEHICLE INFORMATION OBTAINING MEANS
MEMORY
MAP DATA
42
43
44
45
40
NAVIGATION ECU
41
HMI
50
10
160
FLASH MEMORY
STATION LIST
RDS LIST
RECEPTION QUALITY DB
COMMUNICATION INTERFACE
162
164
166
120
MPU
110
131
132
133
DAB TUNER
DAB DECODER
SIGNAL DETECTOR
134
130
141
142
150
RDS TUNER
SELECTOR
143
SIGNAL DETECTOR
140
20
30
AUDIO AMPLIFIER

FIG. 1

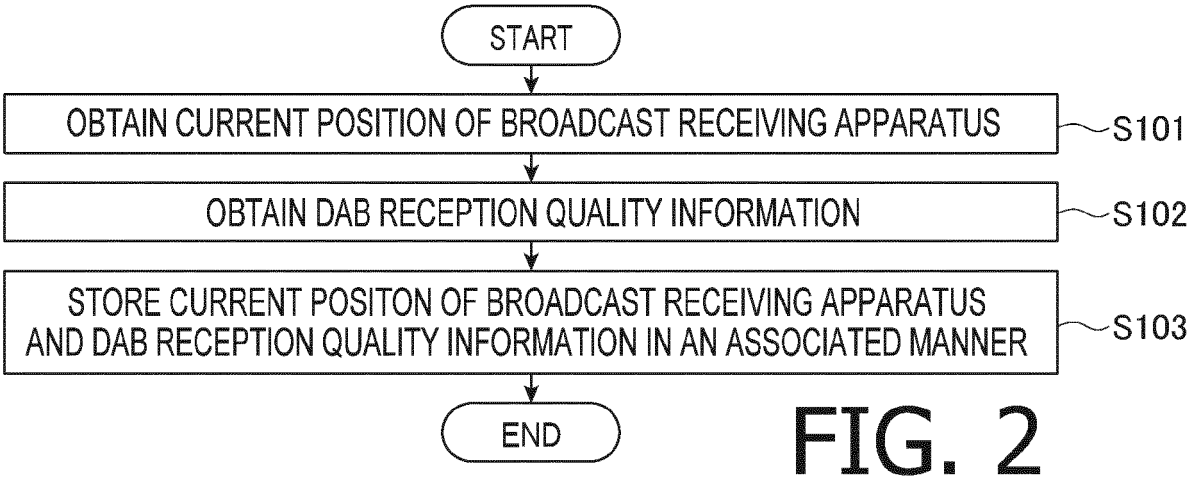
START
OBTAIN CURRENT POSITION OF BROADCAST RECEIVING APPARATUS
S101
OBTAIN DAB RECEPTION QUALITY INFORMATION
S102
STORE CURRENT POSITON OF BROADCAST RECEIVING APPARATUS AND DAB RECEPTION QUALITY INFORMATION IN AN ASSOCIATED MANNER
S103
END

FIG. 2

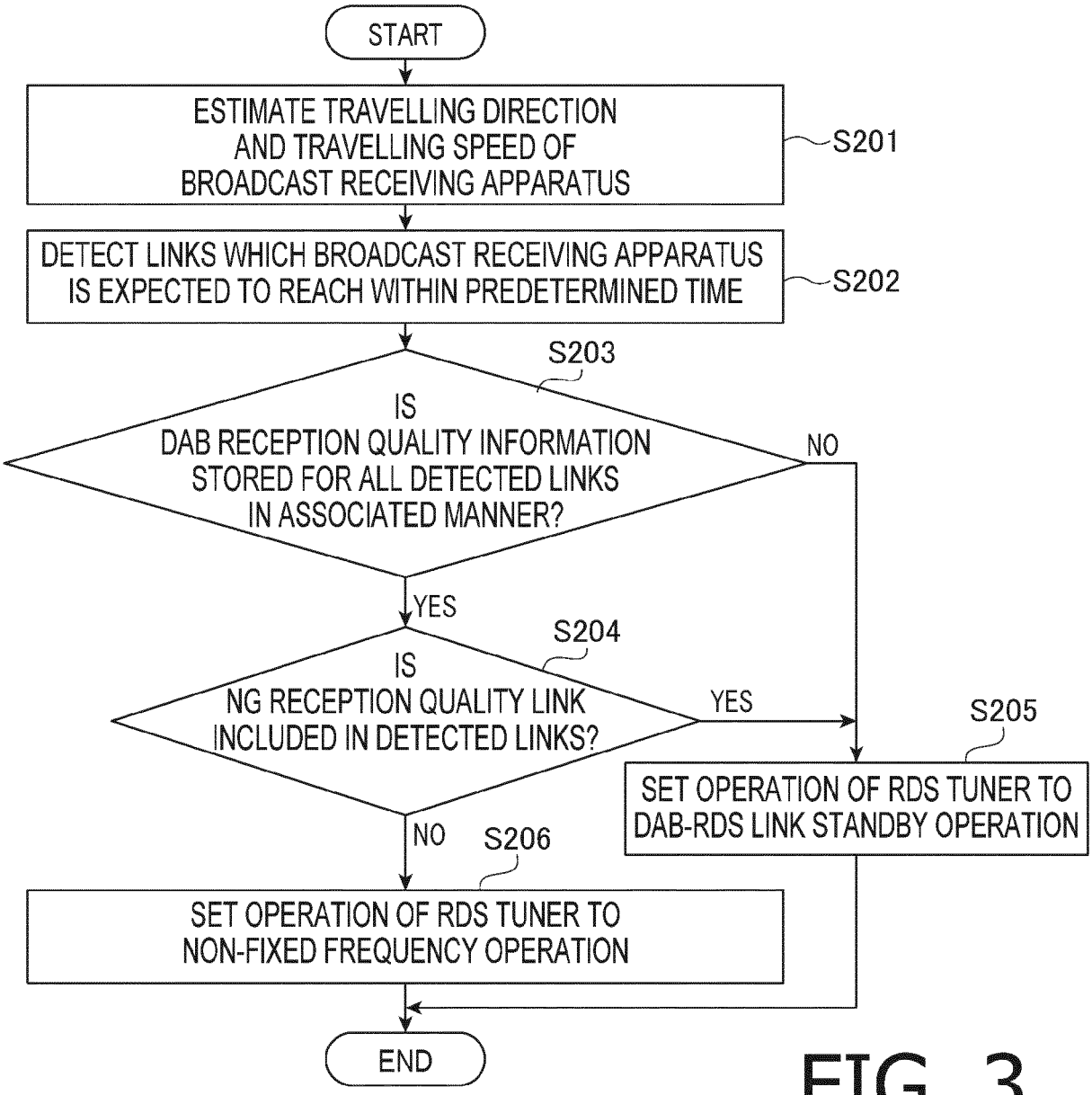
START
ESTIMATE TRAVELLING DIRECTION AND TRAVELLING SPEED OF BROADCAST RECEIVING APPARATUS
S201
DETECT LINKS WHICH BROADCAST RECEIVING APPARATUS IS EXPECTED TO REACH WITHIN PREDETERMINED TIME
S202
S203
IS DAB RECEPTION QUALITY INFORMATION STORED FOR ALL DETECTED LINKS IN ASSOCIATED MANNER?
NO
YES
S204
IS NG RECEPTION QUALITY LINK INCLUDED IN DETECTED LINKS?
YES
S205
SET OPERATION OF RDS TUNER TO DAB-RDS LINK STANDBY OPERATION
NO
S206
SET OPERATION OF RDS TUNER TO NON-FIXED FREQUENCY OPERATION
END

FIG. 3

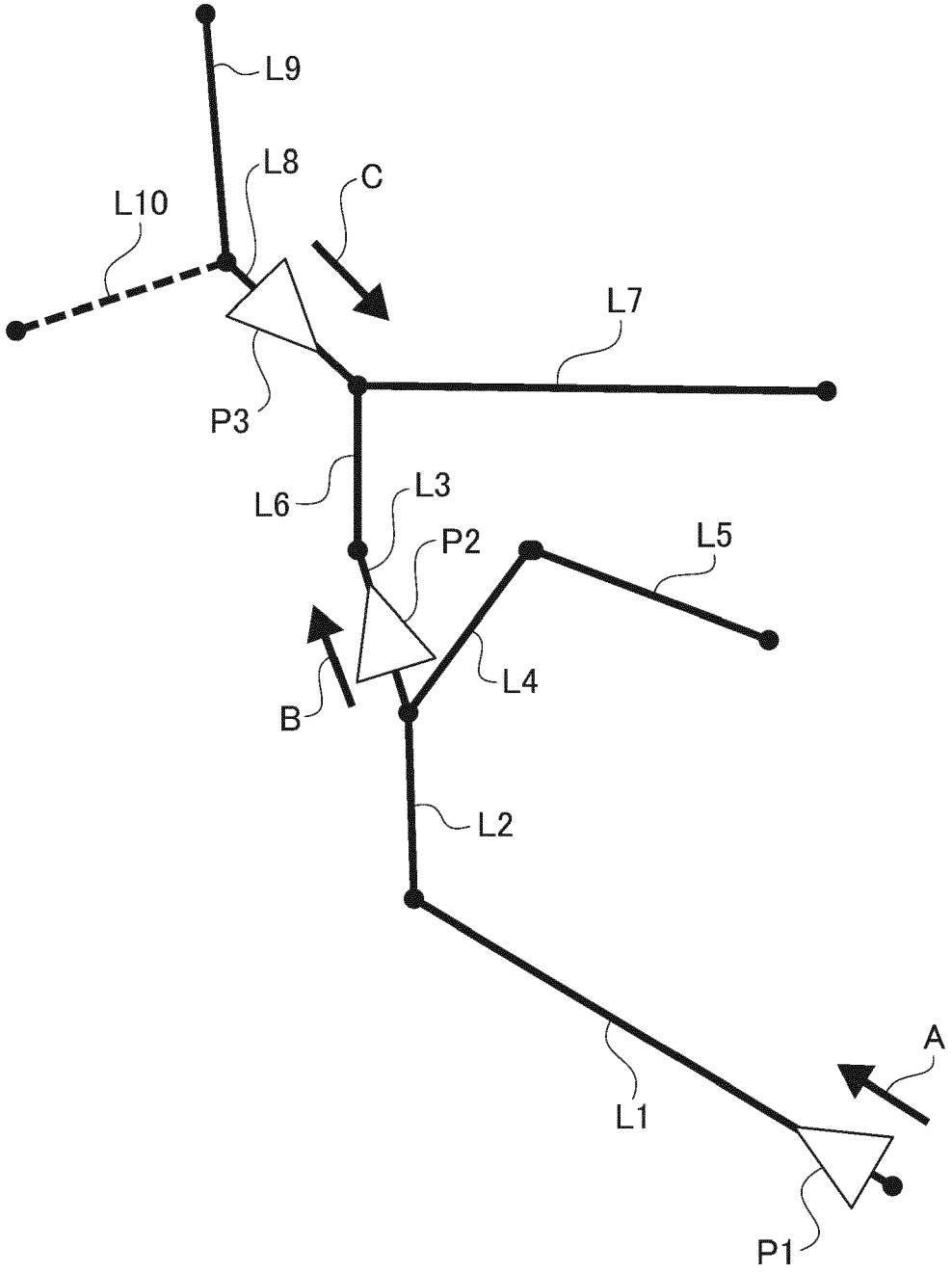

FIG. 4

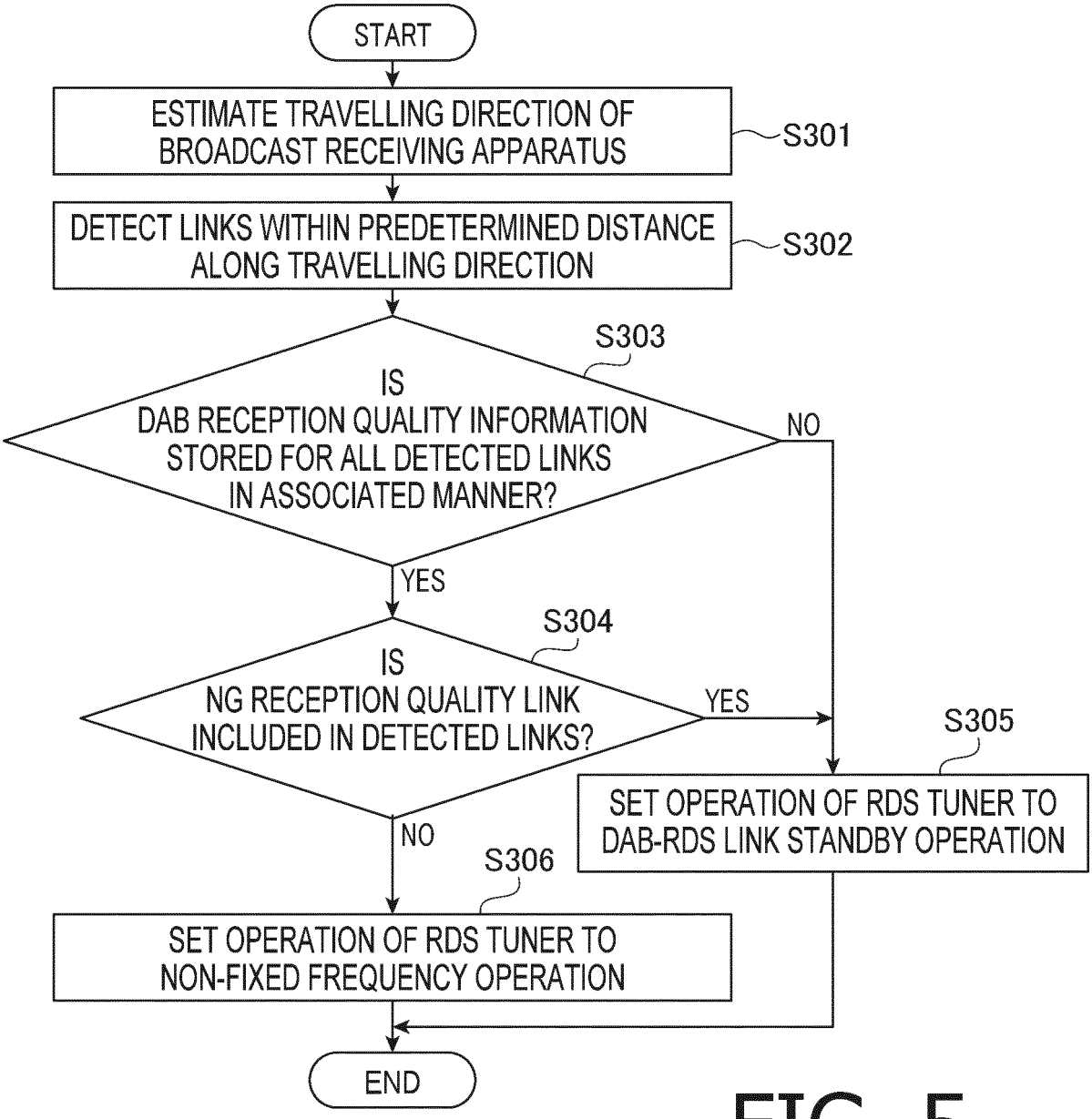
START
ESTIMATE TRAVELLING DIRECTION OF BROADCAST RECEIVING APPARATUS
S301
DETECT LINKS WITHIN PREDETERMINED DISTANCE ALONG TRAVELLING DIRECTION
S302
S303
IS DAB RECEPTION QUALITY INFORMATION STORED FOR ALL DETECTED LINKS IN ASSOCIATED MANNER?
NO
YES
S304
IS NG RECEPTION QUALITY LINK INCLUDED IN DETECTED LINKS?
YES
S305
SET OPERATION OF RDS TUNER TO DAB-RDS LINK STANDBY OPERATION
NO
S306
SET OPERATION OF RDS TUNER TO NON-FIXED FREQUENCY OPERATION
END

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 21 19 5502

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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A	US 2015/124971 A1 (HASLAM ANDREW DAVID MARK [US]) 7 May 2015 (2015-05-07) * paragraphs [0037] - [0053]; claims 1-4 *	1-9	
A	FR 3 073 693 A1 (CONTINENTAL AUTOMOTIVE FRANCE [FR]; CONTINENTAL AUTOMOTIVE GMBH [DE]) 17 May 2019 (2019-05-17) * page 1, line 27 - page 9, line 3 *	1-9	

TECHNICAL FIELDS SEARCHED (IPC)
H04H

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	28 January 2022	Van Hoorick, Jan

CATEGORY OF CITED DOCUMENTS

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28-01-2022

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		WO 2015069611 A1	14-05-2015
FR 3073693 A1	17-05-2019	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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